# SESAM
USER MANUAL

Postresp

Postprocessor for Statistical Response Calculations

DET NORSKE VERITAS

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Postprocessor for Statistical Response Calculations

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Table of Contents

APPENDIX C   PULLDOWN MENUS AND DIALOGUE WINDOWS OF POSTRESPC-1

1 INTRODUCTION

1.1 Postresp – Postprocessor for Statistical Response Calculations

Postresp is a general interactive graphic postprocessor for postprocessing of general responses given as transfer functions in the frequency domain, or postprocessing of time series in the time domain. The transfer functions in the frequency domain part are usually generated by one of the hydrodynamic programs in the Sesam suite but they may as well be transfer functions for any kind of response.

Postresp is a part of the Sesam program suite but can also be used to postprocess frequency dependent results from other external programs writing their results on a standard Sesam Results Interface File.

Postresp may (in the frequency domain) be used as a stand alone program without reading a Hydrodynamic Results Interface File. The user may enter transfer functions interactively or by running an edited command input file.

Using Postresp in time domain, time series are also read from the Results Interface File. The Results Interface File may be generated by Sestra or any other analysis program with the ability to create time series and geometry records on a standard Sesam Results Interface File.

Note: Postresp for the extension TIME is delivered as a separate executable (program) and is documented in a separate user manual.

1.2 Postresp in the Sesam System
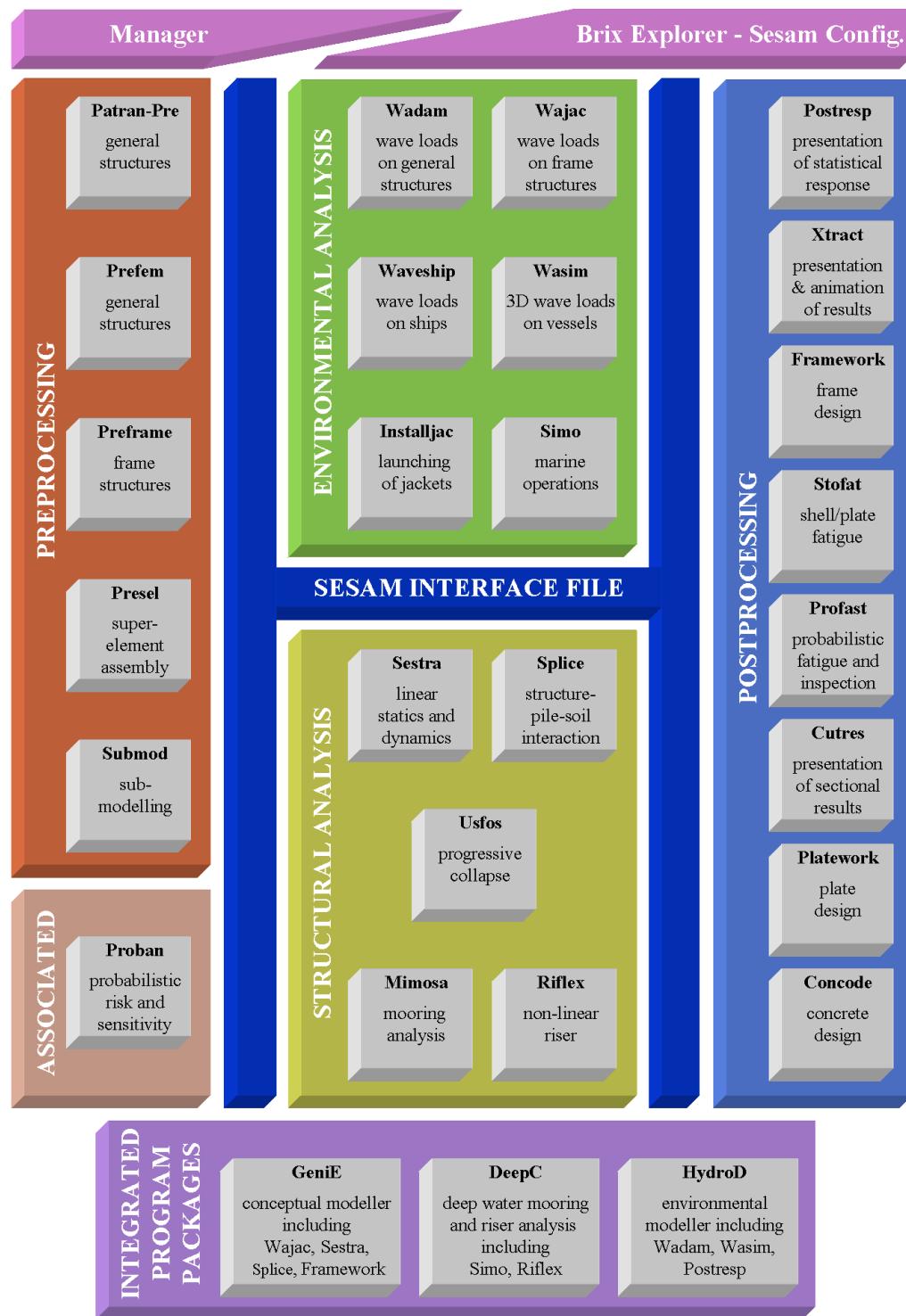
Figure 1.1 Postresp in the Sesam System

1.3   How to read this Manual

Chapter 2 FEATURES OF POSTRESP gives a description of the program features.

Chapter 3 USER'S GUIDE TO POSTRESP explains the program organization with particular descriptions of some of the calculation steps, including some examples. This chapter also contains a description of the internal name conventions.

Chapter 4 EXECUTION OF POSTRESP explains the file types, starting procedures, the Graphical User Interface and some program requirements and limitations.

Chapter 5 COMMAND DESCRIPTION contains a detailed description of the available input commands.

Appendix A contains input and output for tutorial examples.

Appendix B includes additional theory description for Postresp.

Appendix C includes pulldown menus and dialogue windows.

Additional literature is listed in the References part.

1.4   Status List

There exists for Postresp (as for all other Sesam programs) a Status List providing additional information. This may be:

- Reasons for update (new version)

- New features

- Errors found and corrected

- Etc.

Use the program Status for looking up information in the Status List: In Manager click [?]. Then give File | Read Status List and select Postresp. In the Status List Browser window narrow the number of entries listed:

- Entries relevant to a specific version only

- Entries of a specific type, e.g. Reasons-for-Update

- Entries containing a given text string

Click the appropriate entry and read the information in a Print window.

To look up information in the most updated version of the Status List go to our website, www.dnvsoftware.com, click the Support shortcut and then the Sesam Status Lists link and log into this service. Contact us for log-in information.

1.5 Postresp extensions

There are four extensions to Postresp denoted Ext. EQUA, FATG, 2ORD and TIME.

EQUA   used to solve the equation of motion for user specified wave frequencies, given that Postresp has read in global matrices and first order excitation forces.

FATG   used to perform fatigue analysis in the frequency domain

2ORD   used to operate on second order sum and difference results.

TIME   used to perform statistical postprocessing on any time series stored on the Results Interface File.

Note: **The extension TIME is available as a separate executable named Postresp_TIME.**

Table 1.1 gives an overview of the different features that are applicable to the extensions.

The commands applicable to the extension TIME are given in a separate user manual.

Table 1.1

		EXTENSION		
CHAPTER		EQUA SOLVER	FATG FATIGUE ANALYSIS	2ORD 2.ORDER
2.9	Equation of Motion	x		
2.11	Second Order Statistics			x
2.12	SN-curves		x	
2.13	Stochastic Fatigue Calculations		x	
3.9	Solving Equation of Motion	x		
3.11	Calculation of Second Order Statistics			x
5	COMMAND DESCRIPTION	x	x	x

2 FEATURES OF POSTRESP

2.1 Response Variables

The transfer functions are called response variables in Postresp. They are addressed by a character name consisting of up to eight letters. The user may allocate any name to new response variables generated by the CREATE command, except those already defined by the internal name convention, ref. Chapter 3.

The transfer functions are usually read from a Results Interface File, but they may also be typed in directly. The transfer functions may be combined, either as standard motion combinations for displacement, velocity or acceleration, or by special combinations where the user is free to add transfer functions with scaling factors in any way.

The transfer functions may be printed, displayed, saved in a plot file or plotted on an on-line printer.
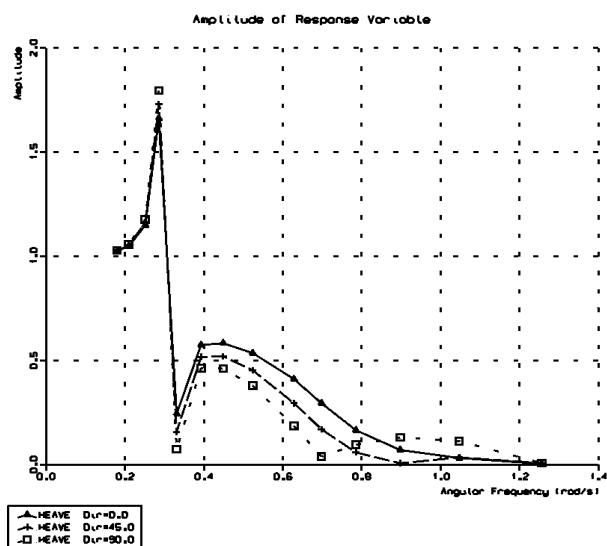
Figure 2.1   Response variable for HEAVE motion

If there are sectional forces given with the section numbers increasing continuously from 1 to n, Postresp also offers a sectional force diagram, for a user specified degree of freedom.

2.2   Wave Spectra

The wave spectra are different types of wave load spectra. There are three different standard wave spectra and one user defined spectrum. The wave spectra are:

PIERSON-MOSKOWITZ   with input of the significant wave height H_s and the zero up-crossing period T_z.

ISSC   with input of the significant wave height H_s and the mean period T_1.

JONSWAP   with input of either the significant wave height Hs and the zero upcrossing period T_z, or α and the peak angular frequency ω_P, and the parameters γ, σ_A and σ_B.

TORSETHAUGEN   with input of the significant wave height H_s and the peak period T_p. Ref. /11/

OCHI-HUBBLE   with input of the significant wave height H_s and the peak period T_p, one pair for contribution from swell and one for wind-generated sea. **Note that the application of this spectrum is restricted to creation of response spectrum, generation of short term statistics and print and display of the spectrum.**

GENERAL GAMMA   with input of the significant wave height H_s, the zero upcrossing period T_z, and the parameters 'l' and 'n'. When l=5 and n=4, the general gamma spectrum will correspond to a Pierson-Moskowitz spectrum.
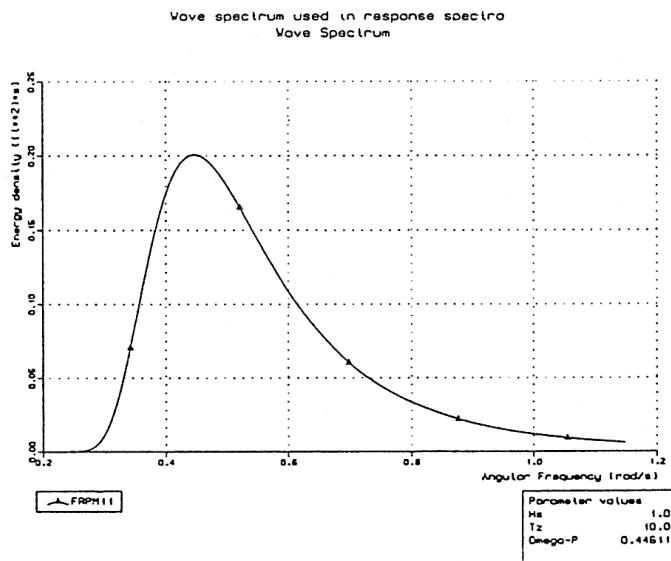
Figure 2.2 Pierson-Moskowitz spectrum for Hz=1.0 m and Ts=10 sec

If another spectrum type is required, the user has to type in each angular frequency and the corresponding ordinate value. Linear interpolation will be applied between the spectral ordinates specified.

The print of a wave spectrum contains the spectrum parameters. It is possible to dump out the spectrum values for a given spectrum name. A wave spectrum may also be displayed or plotted, except the general gamma spectrum.

2.3   Wave Energy Spreading Functions

The wave energy spreading functions are used when statistical calculations are required for short crested sea, i.e. if the user wants to take into account other directions than the current main wave direction.

The wave spreading functions may only be used if the available wave directions cover 180 degrees or more, and if the spacing is constant. If the program does not find a direction, it will use the direction for + or - 180 degrees. Note that this is only correct if the vessel does not have any forward speed and is doubly symmetric

Example:

   Wave directions available: 0 45 90 135 180 degrees.

   Main wave direction: 45 degrees and short crested sea.

   Which results in:

   The relative directions: -90 -45 0 45 90 degrees.

   and available directions: 135 0 45 90 135 degrees.

The wave energy spreading function may be a $\cos^n(\theta)$, where n is an integer value, i.e. $\cos^2(\theta)$, $\cos^3(\theta)$ etc. The function value is not directly the $\cos^n(\theta)$ value, but the integral of the function from $\theta - \Delta\theta/2$ to $\theta + \Delta\theta/2$.
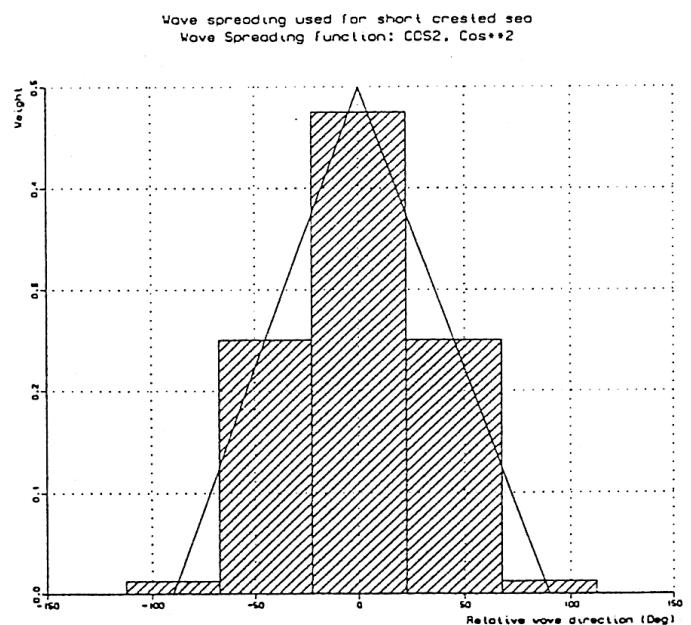
Figure 2.3   Wave spreading function based on $\cos^2(\theta)$

A user specified spreading function is typed in with the relative directions and the corresponding weights.

When a wave spreading function based on a cosine function is printed, displayed or plotted, the program will ask for which relative spacing to use in the presentation.

2.4   Wave Statistics

The wave statistics model describes the sea state conditions during a long term period, and consists of mainly zero upcrossing periods, T_z, and significant wave heights, H_s, and their probability of occurrence. These values may be given through an approach based on Nordenstrøm's theory or by specifying a scatter diagram directly. The wave statistic models are given names and may be assigned to correct wave direction independently of each other.

The Nordenstrøm model is formulated and based on the fact that data for stationary sea state is usually given in terms of visually estimated periods, T_v, and visually estimated wave heights, H_v. A further description of the theory supporting the model, and the different parameters involved, is presented in Appendix B.

The scatter diagram type offered is a H_s-T_z diagram where the probability of each non-zero "box" in the diagram must be specified. The diagram may be identical for all wave directions, omnidirectional, or it may be wave direction dependent. Scatter diagrams may be read from an external file provided that the file is given in the Results Interface File format.

The ISSC scatter diagram offered is a H_s-T_1 diagram and is required for the ISSC wave spectrum.

Two standard scatter diagrams are now automatically generated in Postresp:

- DNV-NA (DNV North Atlantic)

- DNV-WW (DNV World Wide trade)

The wave statistics may be printed. Neither display nor plot capabilities are available.

2.5   Response Spectra

A response spectrum may be either an auto-spectrum or a co-spectrum. The spectra are not named, but will be identified by integer numbers. A response spectrum is generally a wave spectrum multiplied by the square of the transfer function for an auto-spectrum or by the cross function for a co-spectrum. There will be one spectrum generated for each response available, main wave heading, and each wave spectrum used. The internal numbering conventions are given in Section 3. The response spectra are given as double amplitude response. For further description of the theory, please see Appendix B.

The printout of an auto-spectrum contains the moments, the response spectrum width parameter ε, T_z for the response spectrum, and the short term parameter, while a co-spectrum printout contains the covariance, the correlation coefficient, and the zero moments for the auto-spectra of the two response variables in question.

Except for spectra generated by a general gamma spectrum, it is possible to dump the spectrum values for a given spectrum name. The response spectra may also be displayed or plotted, with a maximum of 6 spectra in the same graph.
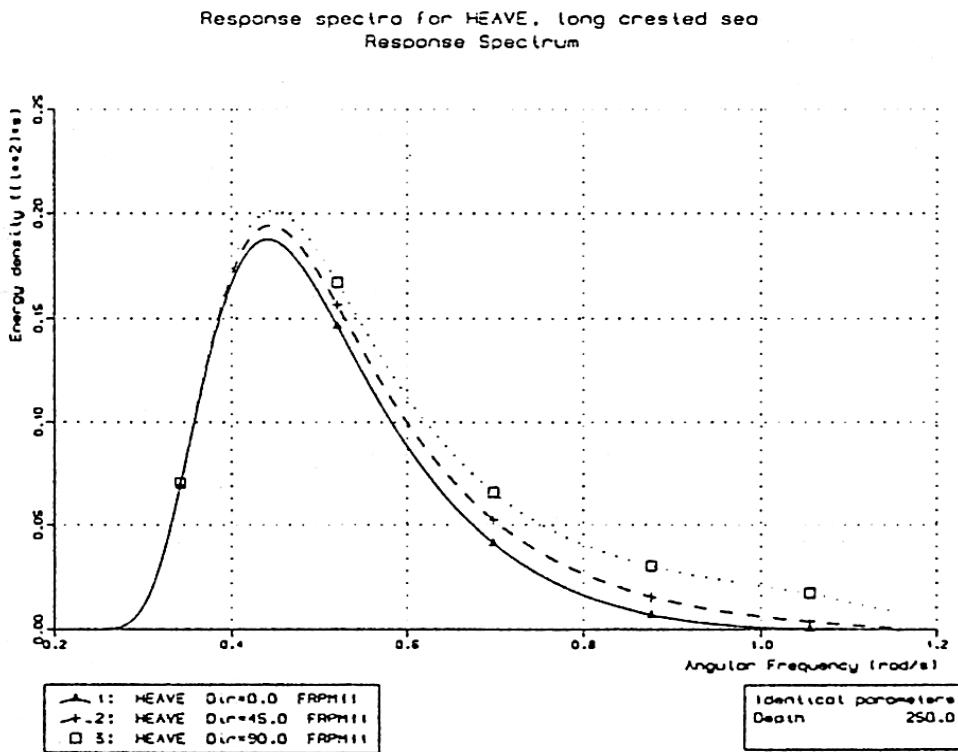
Figure 2.4   Response spectra for HEAVE motion

2.6   Short Term Response

The short term response option calculates the response of the structure based on an energy spectrum for a stationary sea state and the transfer function for the structure. It is defined as the mean of one third of the largest responses in the response spectrum and it is divided by the significant wave height. Note that the short term response for the second order drift forces is the expected value (non-harmonic).

The short term response is given as a function of T_z-values (full-range calculation of wave spectra), and it is determined by:

$$X1/3 \; = \; \frac{4 \cdot \sqrt{m_0}}{H_s}$$ (2.1)

where m_0 is the zero moment of the response spectrum for each T_z value, and H_s is the significant wave height. From this it follows that the short term response is given as the double amplitude response per significant wave height.

Note: It is not possible to calculate the short term response from a set of user defined wave spectra.

The short term response may be printed, plotted, or displayed as a function of the T_z-values.
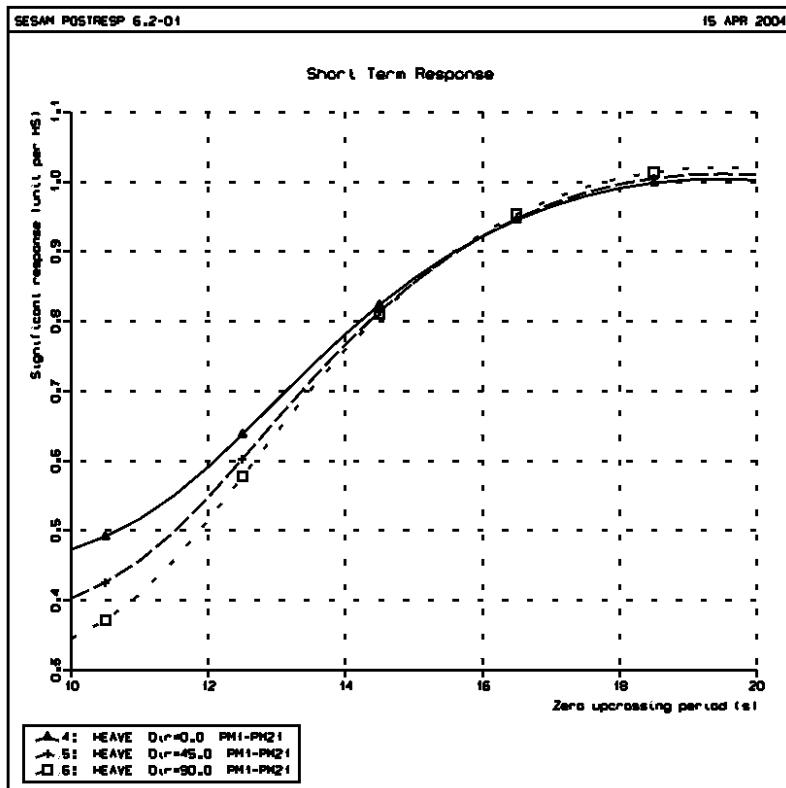
Figure 2.5   Short term response for HEAVE motion

2.7   Short Term Statistics

The short term statistics are available only through the PRINT command. Two distribution methods are implemented, Rayleigh and Rice. Short term statistics are calculated for a given response spectrum based on three different inputs:

• Given a response level, the probability of exceedance will be printed.

• Given a sea state duration, the number of zero upcrossings, the probability of exceedance and an estimate of the most probable largest response level will be printed.

• Given a probability of exceedance, the corresponding response level will be printed.

The short term statistics is given as a single amplitude response.

2.8   Long Term Response

The long term response calculation offered includes long term calculation with either Nordenstrøm's model or a scatter diagram. Speed-reduction can be taken into account in long term response calculations.

The print from the long term calculation includes response levels for given probability levels, the Weibull parameters estimated when fitting the short term parameters to a Weibull distribution and the response levels for up to 5 return periods. All of these are printed for each wave direction calculated and, if requested, with all wave directions included.

The display or plot offered, is either a function of the probability level or a function of the wave direction.

If long term responses have been calculated for a set of sectional forces, and these section numbers increase continuously from 1 to n, Postresp also offers a long term sectional force diagram, similar to the option in DISPLAY SECTIONAL-FORCE-DIAGRAM.

The long term response is given as a single amplitude response.
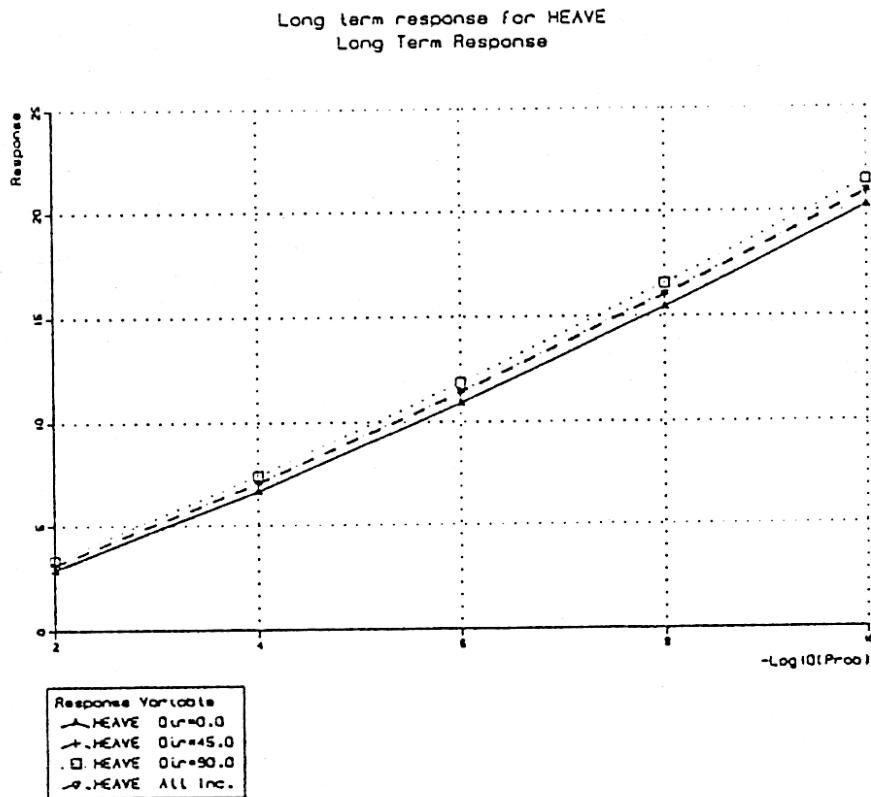
Figure 2.6   Long term response for HEAVE motion

2.9   Equation of Motion

The response variables for the motion of the structure are obtained by solving the equation of motion. In Postresp, the response variables may be user-defined or they are read from a Results Interface File. The coefficients in the equation of motion may also be read from a Results Interface File and the restoring and body-mass coefficients may be changed by the CHANGE MATRIX command.

Solving the equation of motion internally in Postresp, the user has the opportunity to vary coefficients like body mass or flotation area while analysing the response of the structure.

It is also possible to interpolate the coefficients between the frequencies for which they are given on the Results Interface File. The advantage of doing this is that the coefficient matrices are normally linear functions of the frequencies and that a lot more information is thereby obtained compared to interpolating the response variables themselves.

For example, interpolation of the coefficients between frequencies on each side of the peak frequency may give a response value very close to the correct peak value, even if the response values at the frequencies on each side of the peak are both much lower than the peak value.

Since generation of coefficients like added mass and damping for the equation of motion is quite CPU consuming, these features may save some CPU time and serve as a powerful tool for analysing hydrodynamic data.

2.10   Workability Analysis

Postresp offers the possibility to make workability analysis for a given response variable, wave direction and allowable double-amplitude response level. As for the calculation of long term responses, a scatter diagram has to be assigned. This can be done by creating a new diagram interactively or by reading from an external file given on Sesam Interface File format, or by selecting one of the predefined diagrams. Note that only a scatter diagram may be used as the wave statistics model, not the Nordenstrøm model.

The procedure for performing the workability analysis (up-time) is similar to the long term response. For each cell a significant response $4\sqrt{m_0}$, is calculated and scaled with the actual significant value H_s. This value is compared with the user specified allowable double-amplitude response level.

If the significant response level is below the allowable value, the number of occurrences (or probability) of this sea state is stored. Doing this for all sea states (cells) and adding all occurrences which were below the allowable level, the proportion of this sum compared to the total number of occurrences in the scatter diagram, Postresp will provide the user with a direct measure of the workability.

In order to offer a combined workability feature, there is also a possibility to select more than one response variable. For each response variable, an allowable double-amplitude response level must be given.

Using a combined option, the program will calculate both the individual and the combined workability in order to present both results in a print table. The combined workability may be seen as a lower envelope in the scatter diagram.

2.11   Second Order Statistics

The calculation of second order response statistics is only available through the PRINT command.

For systems modelled as second order Volterra, that is by linear and quadratic transfer functions, Postresp provides direct calculation of statistics of the system output. Input data for the analysis are the directional wave spectrum $S_x(\omega, \beta)$, the bi-directional sum and difference frequency quadratic transfer functions H^-_2, and the directional linear transfer function. The first four statistical moments, the mean, standard deviation, skewness and kurtosis of the system output are reported. In addition, extreme levels satisfying some given probability of exceedance can be reported.

Long crested waves are of course a special case of this general analysis. The first order effects and the contributions from the sum or difference frequencies in the second order output, can be individually included or excluded from the calculation. It should be noted that when first order effects are included, the reported moments and extremes will account for the interaction of first and second order effects.

This type of model and analysis have been applied, for example, to study the high frequency springing response of tension leg platforms. Similarly, the slow drift analysis of moored vessels has been conducted using the difference frequency part of the Volterra model.

2.12 SN-curves

This is used to define the fatigue characteristics of a material subjected to repeated cycle of stress of constant magnitude. The SN-curve delivers the number of cycles required to produce failure for a given magnitude of stress. The SN-curve may be calculated by the program or it may be user defined.

The program generates the following SN-curves:

Name	m	S	LogN	LogA
API-X	4.380	3.500E+07	8.301	41.344
API-XP	3.740	2.300E+07	8.301	35.834
DNV-X	4.100	3.400E+07	8.301	39.180
DNVC-I	3.000	7.644E+07	7.000	30.650
DNVC-Ib	3.000	8.318E+07	7.000	30.650
DNVC-II	3.000	6.213E+07	7.000	30.380
DNVC-III	3.000	9.190E+07	7.000	30.890
DNVC-IIIb	3.000	1.000E+08	7.000	31.000
DNVC-IV	3.000	7.470E+07	7.000	30.620
NS-B-SEA	4.000	4.744E+07	8.301	39.006
NS-C-SEA	3.500	3.322E+07	8.301	34.626
NS-D-SEA	3.000	1.966E+07	8.301	30.182
NS-E-SEA	3.000	1.730E+07	8.301	30.015
NS-F-SEA	3.000	1.467E+07	8.301	29.800
NS-F2-SE	3.000	1.291E+07	8.301	29.534
NS-G-SEA	3.000	1.074E+07	8.301	29.394
NS-T-SEA	3.000	1.939E+07	8.301	30.164
NS-W-SEA	3.000	9.233E+06	8.301	29.197

where:

Name   Name of the SN-curve

m   Inverse slope of the first and second branch of the curve

S   Stress range at intersection with next branch (units: N/m^2)

LogN   Logarithm of number of cycles at branch intersection

LogA   Logarithm of number of cycles for stress range = 1.0

The SN-curve is converted from SI base units to the current set of consistent units based on the assumption that the Young's modulus of material corresponds to steel (with $E = 2.1 \times 10^{11} \ N/m^2$).

The user defined SN-curve requires the definition of slopes and intersection points. A maximum of three slopes (and two intersection points) may be specified. A consistent set of units must be used.
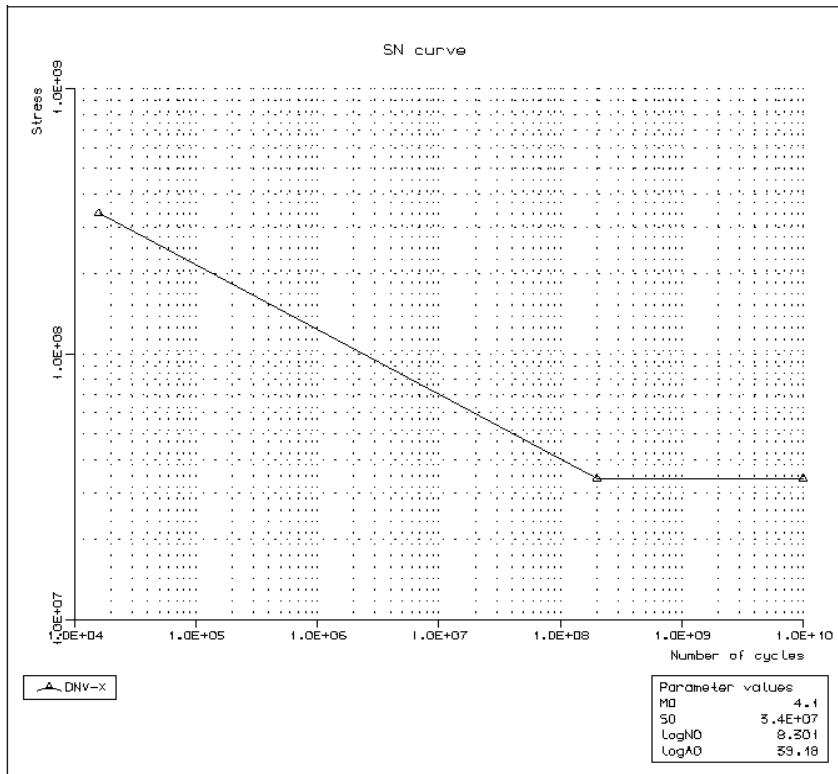
Figure 2.7   S-N Curve DNV-X

2.13   Stochastic Fatigue Calculations

A stochastic fatigue analysis requires that a linearised frequency domain analysis is executed first. This will generate a set of stress transfer functions which can be read into Postresp through the Hydrodynamic Results Interface File and used in the short or long term stochastic fatigue calculations.

In the short term fatigue calculation, the fatigue damage can be obtained for a short term duration of a given sea state. The short term fatigue assumes Rayleigh distribution of the stress ranges and takes response spectra, S-N curves, and durations as input. The expected value for failure is then calculated and printed.

Long term fatigue calculation can be calculated either based directly on a scatter diagram where Rayleigh distributions are assumed for each cell or based on a Weibull-fit from a long term response calculation of the significant responses (stress ranges) of the cells. Speed-reduction can be taken into account in long term fatigue calculations.

Both the short term and long term fatigue calculations are based on the assumption that a single-slope or bi-linear S-N curve is used.

Further description is given in Appendix B THEORY AND FORMULATION, Chapter B 7 Frequency Domain Fatigue.

3 USER'S GUIDE TO POSTRESP

Chapter 3 is divided into three parts:

- Sections 3.1 gives a short description of the general usage of Postresp.

- Sections 3.1 through 3.9 describe different modes of operating Postresp, such as generating response variables, response spectra, short and long term responses, workability analysis and how to solve the equation of motion for a defined set of frequencies.

- Section 3.11 contains the internal name convention.

For a quick introduction, read Section 3.1 first.

3.1 Short Introduction to how to use Postresp

The most used commands in Postresp are CREATE, PRINT, DISPLAY and PLOT. The CREATE command contains both subcommands for creating tools such as wave spectra and wave energy spreading functions, and subcommands for creating response spectra and short or long term responses.

To give an illustration on a simple, but very often used way of running Postresp, the next items will show how to examine and make statistics on two response variables, HEAVE and PITCH. The numerical values used are taken from the example in Appendix A 1 FLOATING BARGE. More detailed descriptions of some of the items are given in the following sub-chapters. We assume that the user has started Postresp with a new database file, and that the #-prompt is offered.

a Read in a Global Response Results Interface File (G-file), containing the transfer functions using the FILE READ command.

b Use the PRINT or DISPLAY commands to verify the data read from the G-file. Print or plot to file is obtained by using the SET PRINT DESTINATION FILE or SET DISPLAY DESTINATION FILE command respectively. Plots may also be obtained if the PLOT command is used after a display has been created. The PLOT command directs the last display to a file or a connected printer depending on the command SET PLOT FORMAT. Examples:

```
PRINT OVERVIEW ALL
PRINT RESPONSE-VARIABLE HEAVE *
DISPLAY RESPONSE-VARIABLE PITCH ( 0 45 90 )
```

c   CREATE wave energy spreading function if short crested sea is required. Example of a spreading function named COS2:

```
CREATE WAVE-SPREADING-FUNCTION COS2 'Cosine power 2' COSINE-POWER 2
```

d   CREATE wave spectra for use in generating response spectra and short term response. The FULL-RANGE option will generate a set of wave spectra with equal H_s-values and for a range of T_z-values. The names generated consist of the user defined prefix, up to 4 letters and a sequential numbering. Example given for a range from $T_{zmin} = 5.0$ to $T_{zmax} = 15.0$ with a step of 0.5 for a spectrum type of Pierson-Moskowitz:

```
CREATE WAVE-SPECTRUM FRPM 'Full range with Tz= '
PIERSON-MOSKOWITZ FULL-RANGE 5.0 15. 0.5
```

e   Generate response spectra for wanted transfer functions and wave spectra. These response spectra might be used in calculating short term extreme statistics. The response spectra generated are numbered sequentially. Example for HEAVE, PITCH, 3 wave directions, a wave spectrum named FRPM11 with H_s=1.0 and T_z=10.0, and short crested sea:

```
CREATE RESPONSE-SPECTRUM (HEAVE PITCH) (0 45 90) FRPM11 COS2
```

f   Generate short term response for wanted transfer functions and a given T_z-range. The short term response is given as a function of the T_z-values used. Example for HEAVE, PITCH, 3 wave directions, Pierson-Moskowitz spectra with sequence number 1 through 21, and short crested sea:

```
CREATE SHORT-TERM-RESPONSE (HEAVE PITCH) (0 45 90) FRPM 1 21 COS2
```

g   Use the PRINT or DISPLAY commands to examine the response spectra and the short term responses generated. Examples:

```
DISPLAY RESPONSE-SPECTRUM ( 1 2 3 )
DISPLAY SHORT-TERM-RESPONSE ( 1 2 3 )
PRINT RESPONSE-SPECTRUM *
PRINT SHORT-TERM-RESPONSE *
```

h   If short term extreme statistics are required, this is available through the PRINT command. The statistics operates on generated response spectra. An example working against the response spectra generated on HEAVE and PITCH, and with a Rayleigh distribution and short term sea state duration as input:

```
PRINT SHORT-TERM-STATISTICS RAYLEIGH
SEASTATE-DURATION (3600 10800) (1 2 3 4 5 6)
```

3.2   Generation of Combined Responses

Combined responses may be either standard combinations of motions, as absolute motions or relative to the sea surface elevation, or special (force) combinations where the user in principal is free to combine any transfer functions, not only forces. The only requirement to the transfer functions in a combination is that they must contain the same wave directions and angular frequencies.

a) Standard motion combinations are rigid body combinations in a given (specific) point on the structure. The motions may be displacements or derived values, i.e. velocities or accelerations, and they are available for the three translation components. Some or all of the six degrees of freedom may be included, and each component contributing is added together with a multiplied weight arm. Figure 3.1 shows a standard absolute combination where the motion in the z-direction is wanted in point SP.
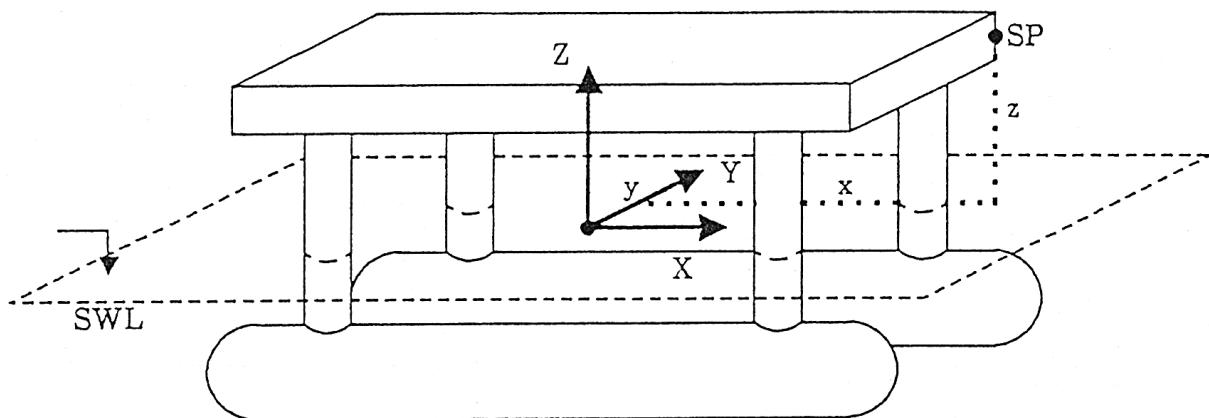
Figure 3.1   Standard absolute combination in point SP

The equation used is:

$$TRSP_Z = TRC_{HEAVE} + y \cdot TRC_{ROLL} - x \cdot TRC_{PITCH} \qquad (3.1)$$

where:

TRSP   the resulting transfer function in point SP.

TRC   the transfer functions at the origin of the global coordinate system (in the free surface, SWL).

x   the local x-coordinate.

y   the local y-coordinate.

The command for the standard motion combination given above is:

```
CREATE RESPONSE-VARIABLE ADISZSP 'Abs. displacement in SP'
COMBINED-MOTION SP * DISPLACEMENT ABSOLUTE Z
```

b) Force combinations are mainly appointed to offer the user an option to combine sectional force components, to obtain resulting forces in a specified point in a section of the structure. This is very often used in connection with ship analysis. Each component is added together with a scaling factor. The user may add as many components as wanted. By this the user also may combine any transfer functions. The program DOES NOT check what type of responses the user combines. Figure 3.2 shows a sectional force combination where the transfer function for the total split force in point A of section number 3 is established.
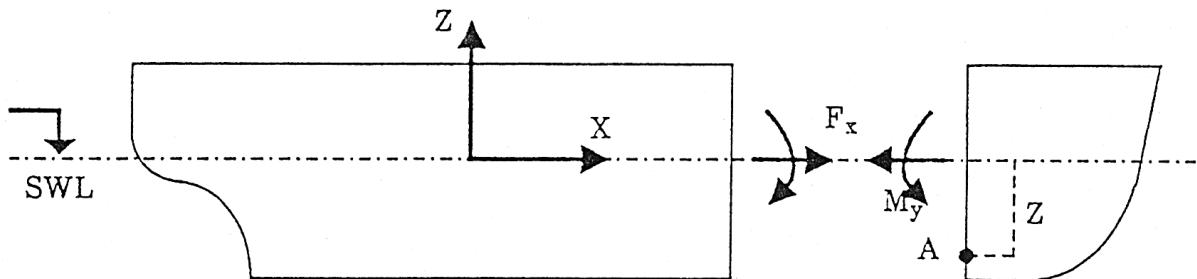
Figure 3.2   Sectional force in point A of section number 3

The equation used is:

$$TRA_{FX} = TRC_{FX} + z \cdot TRC_{MY} \tag{3.2}$$

where:

TRA   the resulting transfer function in point A.

TRC   the transfer functions at the origin of the global coordinate system (in the free surface, SWL).

z   the moment arm about the y-axis.

The combined transfer functions may be used as any other transfer function in short or long term statistical calculations.

The command for the force combination given above is:

```
CREATE RESPONSE-VARIABLE SPLITSP 'Split force in section A'
GENERAL-COMBINATION SECL31 1. SECL35 -1.5
```

3.3   Calculation of Response Spectra

A response spectrum is generated by multiplying the square of the transfer function with a given wave spectrum. The calculation may take into account short crested sea, by giving each wave direction included a specified weight. The weight is generated through a wave spreading function, usually a cosine function. The response spectra are given as double amplitude response.

Each response spectrum is given a reference number. This reference number will be used when plotting or printing the spectrum, or when short term statistics is calculated. The internal numbering system is given in Section 3.11. In addition to the reference number, the program offers a descriptive text for identification of the spectrum and for information of what basic variables the spectrum is created from.

To generate a spectrum the user must input the name of the response variable for which the spectrum shall be created. Further input is for which main wave direction and which wave spectrum the response spectrum is to be calculated. The user also has to input whether long crested sea or short crested sea with a given wave spreading function, shall be used.

The program offers a wildcard alternative on each level in the command structure, so the user may for instance have the response spectra calculated for all response variables, all wave directions and for all wave spectra. If short crested sea is used, and the user has a large number of response variables or wave directions, please be aware of the CPU-consumption, which may be high. If the number of response variables is n_{tf}, the number of wave directions m_{wd} and the number of wave spectra k_{sea}, the total number of response spectra generated will be:

$$n_{tot} = n_{tf} * m_{wd} * k_{sea}$$

Two examples are given below. One with long crested sea and one with short crested sea and a wave spreading function called COS2. The response spectra are requested for HEAVE and PITCH motion, wave directions 0, 45 and 90 degrees, and for a wave spectrum named FRPM11 with H_s=1.0 and T_z=10.0.

```
CREATE RESPONSE-SPECTRUM ( HEAVE PITCH ) ( 0 45 90 ) FRPM11 NONE
CREATE RESPONSE-SPECTRUM ( HEAVE PITCH ) ( 0 45 90 ) FRPM11 COS2
```

This will generate a total of 12 response spectra:

Spectrum number 1-3: HEAVE, 0, 45 and 90 degrees and short crested sea.

Spectrum number 4-6: PITCH, 0, 45 and 90 degrees and short crested sea.

Spectrum number 7-9: HEAVE, 0, 45 and 90 degrees and wave spreading function COS2.

Spectrum number 10-12: PITCH, 0, 45 and 90 degrees and wave spreading function COS2.

3.4   Calculation of Short Term Response

The short term response is calculated for a given response spectra. The response spectra are generated by multiplying the square of the transfer function with given wave spectra for a set of zero upcrossing periods. The calculation may take into account short crested sea, by giving each wave direction included a specified weight. The weight is generated through a wave spreading function, usually a cosine function. The short term response is given as the double amplitude response per significant wave height.

Each short term response is given a reference number. This reference number will be used when plotting or printing the spectrum. The internal numbering system is given in Section 3.11. In addition to the reference number, the program offers a descriptive text for identification of the short term response and for information of what basic variables the short term response is created from.

To generate a short term response the user must input the name of the response variable for which the short term response shall be created. Further input is for which main wave direction and what wave spectrum type and T_z range the short term response is to be calculated. The user also has to input whether a long crested sea or short crested sea with a given wave spreading function shall be used.

The program offers a wildcard alternative on each level in the command structure. The user may for instance have the short term responses calculated for all response variables and all wave directions. If a short crested sea is used and there are a large number of response variables or wave directions, please be aware of the CPU-consumption, which may be high. If the number of response variables is n_{tf}, the number of wave directions m_{wd} and the number of T_z values k_{Tz}, the total number of response spectra which contributes to the short term responses will be:

$$n_{tot} = n_{tf} * m_{wd} * k_{Tz}$$

On the other hand, the number of short term responses generated is:

$n_{str} = n_{tf} * m_{wd}$

Two examples are given below. One with long crested sea and one with short crested sea and a wave spreading function called COS2. The short term responses are requested for HEAVE and PITCH motion, wave directions 0, 45 and 90 degrees, and for a Pierson-Moskowitz spectrum with a T_z-range from 5.0 seconds to 15.0 seconds with an increment of 0.5 seconds.

```
CREATE SHORT-TERM-RESPONSE ( HEAVE PITCH )
( 0 45 90 ) PIERSON-MOSKOWITZ 1 21 NONE
CREATE SHORT-TERM-RESPONSE ( HEAVE PITCH )
( 0 45 90 ) PIERSON-MOSKOWITZ 1 21 COS2
```

This will generate a total of 12 short term responses:

   Short term response number 1-3: HEAVE, 0, 45 and 90 degrees and short crested sea.

   Short term response number 4-6: PITCH, 0, 45 and 90 degrees and short crested sea.

   Short term response number 7-9: HEAVE, 0, 45 and 90 degrees and wave spreading function COS2.

   Short term response number 10-12: PITCH, 0, 45 and 90 degrees and wave spreading function COS2.

3.5   Calculation of Long Term Responses

The long term response is calculated based on a long term description of the sea either through a scatter diagram or through an analytic model based on Nordenstrøm's theory. The long term response calculation uses the short term parameters calculated for each response spectrum with a given H_s and T_z value. Short crested sea may also be taken into account. The long term response is given as the single amplitude response.

Each long term response calculated is referred to through the original response variable used. No internal numbering system is introduced. This also influences the storage of the long term responses. If the user wants to calculate a new long term response for a previously used response variable, he either has to use the CHANGE command or to delete the existing results.

Before generating the long term response, the user must assign wave statistics models and probability of occurrence to each wave direction to be included. If the sum of probabilities is equal to 1, Postresp will automatically calculate long term probability for all wave directions included. The wave spectrum shapes and wave spreading function used within the wave statistics models are to be assign on beforehand to each wave statistics model. A Pierson-Moskowitz spectrum will be assumed if not specified otherwise.

To generate a long term response the user only has to input the name of the response variable and the main wave directions for which the long term response shall be created.

The program offers a wildcard for selecting the response variables and for the main wave directions. The necessary computing time in Postresp is normally short, but the long term calculations are the most CPU-consuming parts of Postresp, so the user should use the wildcard with care.

One example is given below, a short crested sea condition with a wave shape as Pierson-Moskowitz (by default) and spreading function called COS2. The long term responses are requested for HEAVE and PITCH motion, all wave directions are taken into account and a Nordenstrøm wave statistics model called NOR1 is used.

```
ASSIGN WAVE-DIRECTION-PROBABILITY 0 0.125
ASSIGN WAVE-DIRECTION-PROBABILITY 45 0.25
ASSIGN WAVE-DIRECTION-PROBABILITY 90 0.25
ASSIGN WAVE-DIRECTION-PROBABILITY 135 0.25
ASSIGN WAVE-DIRECTION-PROBABILITY 180 0.125
ASSIGN WAVE-STATISTICS 0 NOR1
ASSIGN WAVE-STATISTICS 45 NOR1
ASSIGN WAVE-STATISTICS 90 NOR1
ASSIGN WAVE-STATISTICS 135 NOR1
ASSIGN WAVE-STATISTICS 180 NOR1
ASSIGN WAVE-SPREADING-FUNCTION NOR1 COS2 ALL
CREATE LONG-TERM-RESPONSE (HEAVE PITCH) *
```

3.6   Calculation of Short Term Statistics

The short term statistics calculation is only available through the PRINT-command. The statistic calculation will be performed on created response spectra, addressed through their reference number. The short term statistics is given as the single amplitude response.

The input to the calculations are the short term distribution type, Rayleigh or Rice, response-level, probability of exceedance or sea state duration and the spectrum requested.

Three examples are given below. One with response-level as input, one with probability as input and one with sea state duration as input. The response spectra used are related to HEAVE motion.

```
PRINT SHORT-TERM-STATISTICS RAYLEIGH
RESPONSE-LEVEL (0.750 0.900) (1 2 3)

PRINT SHORT-TERM-STATISTICS RAYLEIGH
PROBABILITY-OF-EXCEEDANCE (0.003 0.001) (1 2 3)

PRINT SHORT-TERM-STATISTICS RAYLEIGH
SEASTATE-DURATION (3600 10800) (1 2 3)
```

3.7   Solving Equation of Motion

Solving the equation of motion will be done by the command:

RUN	EQUATION-SOLVER	dir	freq
			ORIGINAL-FREQUENCIES

where **dir** and **freq** are a subgroup of the original directions and specification of additional frequencies, each assumed to be located between pairs of original frequencies (extrapolation is not allowed), for which the solution of equation of motion will be done. It is not possible to specify additional directions.

ORIGINAL-FREQUENCIES is an option for solving the equation of motion for the specified directions and all the original frequencies.

Running additional frequencies, Postresp will interpolate the matrices for the current body if it is a SINGLE body. For a MULTI body system, the matrices for each of the bodies ("auto coupling" matrices) and the matrices for the interaction between bodies ("cross coupling" matrices) will be interpolated.

The following matrices are treated as independent of both frequency and direction:

BODY MASS AND INERTIA

HYDROSTATIC RESTORING COEFFICIENTS

ANCHORING RESTORING

VISCOUS DAMPING

The following are treated as dependent only on frequency:

ADDED MASS

POTENTIAL DAMPING

None of the matrices are treated as dependent only on direction. The excitation forces and the response variables for the motion are dependent on both frequency and direction.

Running the equation of motion, the motion response variables will be updated, while the matrices themselves will NOT be affected. The purpose is to enable the user to introduce additional frequencies when analysing the transfer functions.

Two examples are given below. In the first example, it is assumed that the response variables are given for wave directions 0, 45 and 90 degrees and a calculation of response variables for two additional frequencies, 0.299 and 0.4 is requested.

```
RUN EQUATION-SOLVER (0 45 90) (0.299, 0.4)
```

In the second example, the equation of motion is solved for all original directions and frequencies. This option is used typically when some of the coefficient-matrices are changed by the CHANGE MATRIX command. In the example below, the body mass is set to 1000 and the response variables are re-calculated for the new body mass for all wave directions.

```
CHANGE MATRIX BODY-MATRIX (11 1000 22 1000 33 1000)
RUN EQUATION-SOLVER * ORIGINAL-FREQUENCIES
```

3.8   Workability Analysis

Workability analysis is done by giving the command:

```
CREATE WORKABILITY-ANALYSIS name descr resp,rmsall dir
```

where **rmsall** is the allowable double amplitude level for response variable **resp**.

Before running the workability analysis, the user must assign wave statistics models, only scatter diagrams to each wave direction to be used. The wave spectrum shapes and wave spreading function used on the scatter diagram are to be assign on beforehand.

An example is given below. It is assumed that a wave statistics model with the name SCAT is already created in the form of a scatter diagram and that a wave spreading function named COS2 is created. The workability analysis is to be performed for the response variables HEAVE, PITCH and ROLL with main wave directions 0, 45 and 90 degrees. The wave spectrum shape to be used is the default assignment of a Pierson-Moskowitz spectrum.

```
ASSIGN WAVE-STATISTICS 0 SCAT
ASSIGN WAVE-STATISTICS 45 SCAT
```

```
ASSIGN WAVE-STATISTICS 90 SCAT
ASSIGN WAVE-SPREADING-FUNCTION SCAT COS2 ALL
```

Then the workability analysis named WORK can be done. The allowable double amplitude response level is 1 for all three response variables:

```
CREATE WORKABILITY WORK 'Workability analysis'
( HEAVE 1 PITCH 1 ROLL 1 ) ( 0 45 90 )
```

3.9   Calculation of Second Order Statistics

The calculation of second order response statistics is only available through the PRINT-command. The statistic calculation will be based on predefined wave-spectra, wave energy spreading functions and sea state duration (by default 3 hours), and for a given set of probability of exceedance.

Further input to the calculations is a selected excitation force, if only second-order or first order response in addition is to be included and if difference, sum or both frequencies shall be included.

In the example below, excitation force in vertical direction, main wave direction 0 degrees, a wave spectrum named FRPM10 and a wave spreading function COS2 is selected. The probabilities of exceedance is 0.001 0.0001 and 0.00001.

```
PRINT SECOND-ORDER-STATISTICS DIFFERENCE SECOND-ORDER-ONLY
EXCITATIONFORCE-3 FRPM10 COS2 0 (0.001 0.0001 0.00001)
```

3.10   Calculation of Stochastic Fatigue

The fatigue damage is printed for a set of short term durations (given in seconds) of given sea states (actually for given response spectra, in this case no. 1) and a given SN-curve by execution of the command:

```
PRINT SHORT-TERM-FATIGUE ( ONLY 10800 ) ( ONLY 1 ) DNV-X
```

The total damage for each duration and response spectrum is then presented in a print table.

The short term fatigue calculation assumes Rayleigh distribution of the stress ranges.

Long term fatigue can be calculated based directly on a scatter diagram where Rayleigh distributions are assumed for each cell. The fatigue results are then first calculated and stored by the command:

```
CREATE LONG-TERM-FATIGUE ( ONLY GRES1 ) ( ONLY 0.0 45.0 90.0 ) DNV-X
```

The results can then be printed by giving the command:

```
PRINT LONG-TERM-FATIGUE ( ONLY GRES1 ) ( ONLY 108000 ) SUMMARY
```

The total damage and the contribution to damage from each cell in the scatter diagram and for each direction is then printed.

Long term fatigue based on a Weibull-fit of the significant responses (stress ranges) of the cells in a scatter diagram can also be printed. The command is:

```
PRINT LONG-TERM-FATIGUE WEIBULL ( ONLY GRES1 ) DNV-X ( ONLY 108000 )
```

This requires that a long term response calculation is done for the response variables, in this case GRES1.

3.11   Internal Name Conventions

The response variables read from the Results Interface File, response spectra and short term responses generated by Postresp will have internal generated names or numbers. The following name and number conventions are used:

FORCE*   Transfer functions of first order wave exciting forces and moments

                FORCE1 - force in x-direction

                FORCE2 - force in y-direction

                FORCE3 - force in z-direction

                FORCE4 - moment about x-axis

                FORCE5 - moment about y-axis

                FORCE6 - moment about z-axis

MOTION   Transfer function of first order rigid body motions

                SURGE - translation in x-direction

                SWAY   - translation in y-direction

                HEAVE - translation in z-direction

                ROLL   - rotation about x-axis

                PITCH   - rotation about y-axis

                YAW   - rotation about z-axis

DRIFT*   Transfer function of second order mean drift forces

                DRIFT1 - force in x-direction

                DRIFT2 - force in y-direction

                DRIFT3 - force in z-direction

                DRIFT4 - moment about x-axis

                DRIFT5 - moment about y-axis

                DRIFT6 - moment about z-axis

HDRFT*   Transfer function of horizontal second order mean drift forces

                HDRFT1 - horizontal force in x-direction

                HDRFT2 - horizontal force in y-direction

         HDRFT6 - horizontal moment about z-axis

SECL&&&*   Sectional loads (forces and moments). '&&&' is the section number and '*' the degree of freedom.

         SECL&&&1 - force in x-direction

         SECL&&&2 - force in y-direction

         SECL&&&3 - force in z-direction

         SECL&&&4 - moment about x-axis

         SECL&&&5 - moment about y-axis

         SECL&&&6 - moment about z-axis

PS&P*   Panel pressure, alt. 1, for panel indexes less than 1000. '&' is the section or symmetry plane number and '*' the internal panel index or pressure point number.

P&P*   Panel pressure, alt. 2, for panel indexes larger than 999. '&' is the section or symmetry plane number and '*' the internal panel index.

GRES****   General response number '****'. This response is stored on the Results Interface File with dimension, so this could be any kind of transfer function. The descriptive text connected to a response variable may give a full description of the origin of the response. For instance for stresses, forces or displacements taken from a Sesam results interface file.

ELEV****   sea surface elevation in point number '****'.

PRES****   pressure calculated in point number '****'.

PVEL&&&*   particle velocity in point number '&&&' and degree of freedom '*'.

FRCSUM*   Transfer function for second order excitation forces at sum frequencies.

         FRCSUM1 - force in x-direction

         FRCSUM2 - force in y-direction

         FRCSUM3 - force in z-direction

         FRCSUM4 - moment about x-axis

         FRCSUM5 - moment about y-axis

         FRCSUM6 - moment about z-axis

FRCDIF*   Transfer function for second order excitation forces at difference frequencies.

         FRCDIF1 - force in x-direction

         FRCDIF2 - force in y-direction

FRCDIF3 - force in z-direction

FRCDIF4 - moment about x-axis

FRCDIF5 - moment about y-axis

FRCDIF6 - moment about z-axis

When calculating response spectra, Postresp automatically generates identification numbers. The numbering system is given in table 3.1. It is illustrated by an example.

Input: - all rigid motions

                   - 2 headings (0 and 90 degrees)

                   - 3 wave spectra (FRPM1, FRPM2, FRPM3)

                   - 1 wave spreading function (COS2).

Table 3.1

NO	RESPONSE VARIABLE	WAVE SPECTRUM	HEADING	SPREADING
1	HEAVE	FRPM1	0.	COS2
2	HEAVE	FRPM1	90.	COS2
3	HEAVE	FRPM2	0.	COS2
4	HEAVE	FRPM2	90.	COS2
5	HEAVE	FRPM3	0.	COS2
6	HEAVE	FRPM3	90.	COS2
7	PITCH	FRPM1	0.	COS2
8	PITCH	FRPM1	90.	COS2
9	PITCH	FRPM2	0.	COS2
10	PITCH	FRPM2	90.	COS2
11	PITCH	FRPM3	0.	COS2
12	PITCH	FRPM3	90.	COS2
13	ROLL	FRPM1	0.	COS2
:	ROLL	FRPM1	0.	COS2
19	SURGE	FRPM1	0.	COS2
:	SURGE	FRPM1	0.	COS2
25	SWAY	FRPM1	0.	COS2

Table 3.1

NO	RESPONSE VARIABLE	WAVE SPECTRUM	HEADING	SPREADING
:	SWAY	FRPM1	0.	COS2
31	YAW	FRPM1	0.	COS2
:	YAW	FRPM1	0.	COS2
36	YAW	FRPM3	90.	COS2

As for response spectra, Postresp automatically generates identification numbers for short term responses. The numbering system is illustrated:

Input: - all rigid motions

                - 2 headings (0 and 90 degrees)

                - 1 wave spreading function (COS2).

Table 3.2

NO.	RESPONSE VARIABLE	HEADING	SPREADING
1	HEAVE	0.	COS2
2	HEAVE	90.	COS2
3	PITCH	0.	COS2
4	PITCH	90.	COS2
5	ROLL	0.	COS2
6	ROLL	90.	COS2
7	SURGE	0.	COS2
8	SURGE	90.	COS2
9	SWAY	0.	COS2
10	SWAY	90.	COS2
11	YAW	0.	COS2
12	YAW	90.	COS2

4 EXECUTION OF POSTRESP

Postresp accesses the Hydrodynamic Results Interface File (G-file), generated by the wave load programs of Sesam. This file may also be generated from a structural analysis Results Interface File by the Sesam program Prepost.

The start up of Postresp is described in Section 4.2. This section also describes the files used by Postresp.

The program requirements and limitations are described in Section 4.3 and Section 4.4.

More details on use of graphics mode and line mode are given in Section 4.5 and Section 4.6. All relevant dialogue boxes are shown in Appendix C.

4.1 Program Environment

Postresp is available in the following hardware environments:

- Unix computers of various vendors

- Windows 2000, NT and XP, often referred to as PC

Postresp may be run in three different modes:

- In interactive graphics mode with menus and dialogue boxes, where input may be given using a mouse as well as the keyboard. Graphics mode usage also gives access to the line mode facilities.

- In interactive line mode (Unix only), using only character based input.

- In batch mode, which uses the line mode syntax and facilities.

How to start the program in the different modes is described below.

4.2 Starting Postresp

Start Postresp in graphics mode from the Sesam Manager by one of the commands

Result | Response POSTRESP

Utility | Run | POSTRESP.

If running from the operating system command prompt window, simply type the program name to start the program:

```
prompt> postresp
```

Postresp responds by opening the main window, and overlaying it with a dialogue box requesting the database file prefix, name and status.

Note that the default status is Old, even when Postresp suggests a new database file. Type in the file prefix and name, and select the proper status, then press the OK button (or type <Return>). Pressing the Cancel button will abort the session.

If the file specification is somehow in error, Postresp will give an error message and keep the start-up dialogue box open for a new file specification.

If the file specification is correct, Postresp will open the database file (with extension ".mod") and a journal file with the same prefix and name (but with extension ".jnl"). It will then show some preliminary messages giving the status of some default settings and of the database. These messages are shown in the next session. Finally, the start-up dialogue box will disappear.

4.2.1   Starting Postresp from Manager with Result Menu

In Manager the 'Result' menu will be available when a Results Interface File exits for the current project. In the 'Result' menu Postresp is available under the selection 'Response POSTRESP...', see Figure 4.1. If the 'Result' menu is not available ('greyed out'), click 'Option/Superelement' to specify the actual superelement, or 'Option/Enable All Menus'.
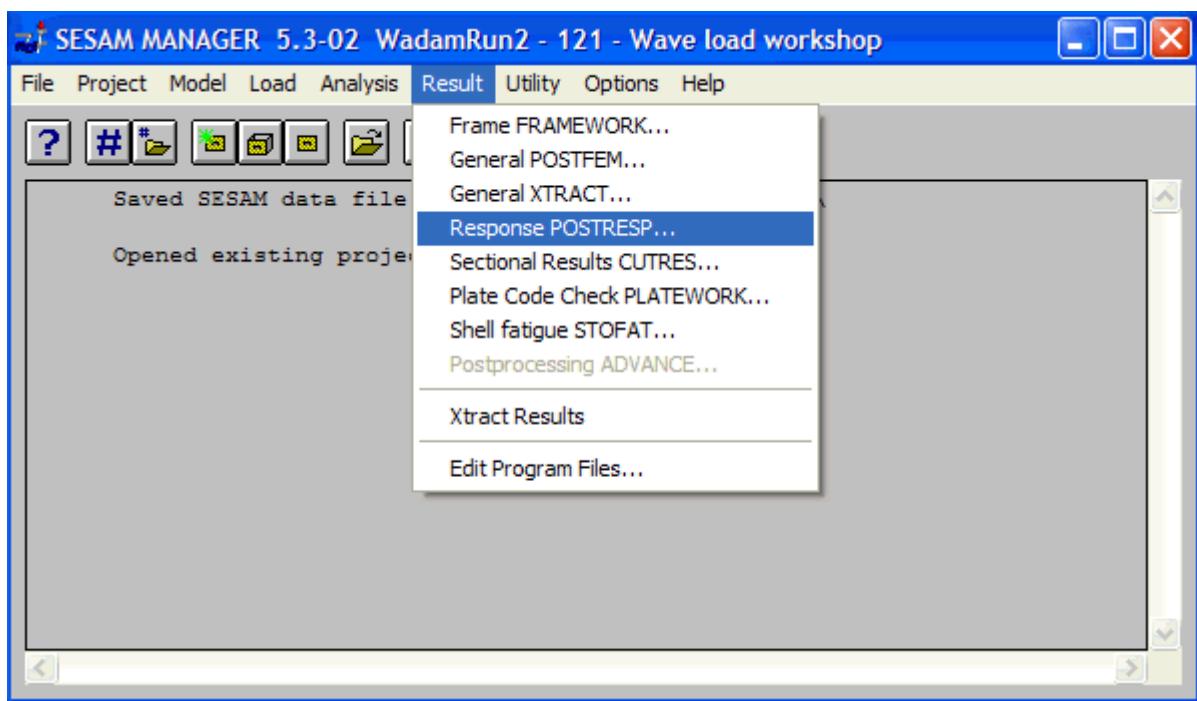
Figure 4.1   Main dialogue of Manager and the Result menu

The 'Response Postprocessing' dialogue for Postresp, see Figure 4.2, has the following parameters:
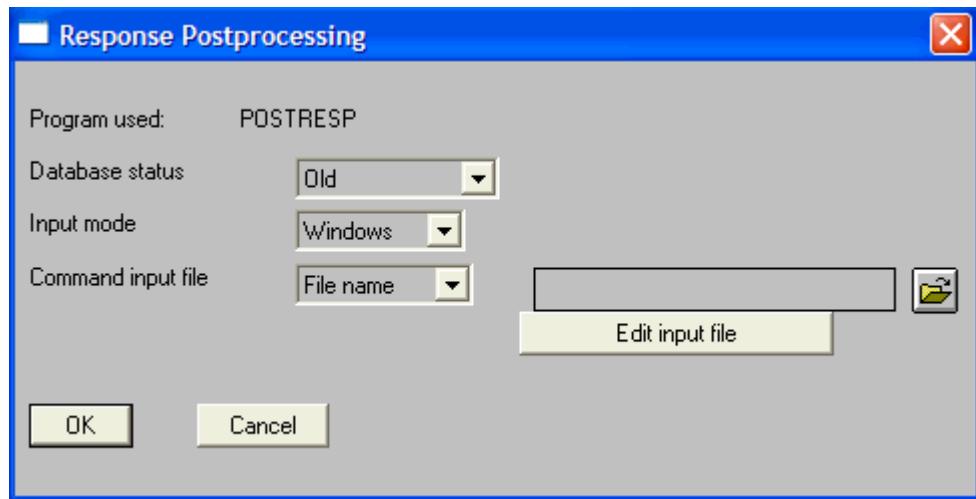
Figure 4.2   Dialogue window for Postresp

Database status:

New	When Postresp has not been run before, or when it is wanted to start Postresp with an empty database
Old	To restart Postresp with an existing model

Input mode:

Window	The only alternative available

Command input file:

None	Postresp will be started and wait for input from the user
Default	Manager will create a few commands to make Postresp establish a model file for the current analysis
File name	An existing journal file containing commands for Postresp should be selected. The commands in the file will be processed by Postresp when it is started.

4.2.2   Starting Postresp from Manager with Utility/Run Menu

Select 'Run...' in the 'Utility' menu of Manager. The 'Run a program' dialogue appears, see Figure 4.3.
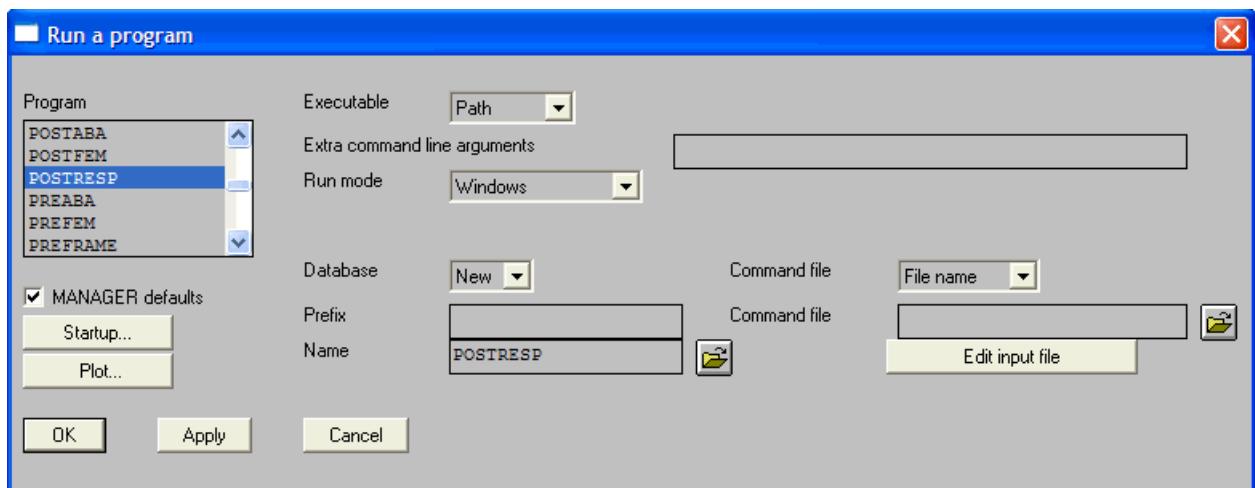
Figure 4.3   The 'Run a program' dialogue of Manager

- Select POSTRESP in the 'Program' selection box and the program executable in the 'Executable' selection box, if alternatives are present.

- Specify the 'Run mode'. Alternatives are 'Windows' or 'Background'. If 'Background' is selected, Postresp is executed without the Postresp dialogue window appearing on the screen.

- Specify 'Prefix, 'Name' and status of the 'Database' file. Status of the database is either 'New', or 'Old', see description of the 'Response Postprocessing' dialogue.

- Select 'File name' and enter name of the 'Command file' for reading an existing journal file containing command lines input for Postresp. If 'None' (default) is selected, Postresp will wait for input from the user.

- Click the OK, or APPLY button to start the Postresp execution. The dialogue window of Postresp appears on the screen and Postresp may now be operated as described in this manual. Exit Postresp and the 'Run a program' dialogue of Manager appears. A new start-up of Postresp may be performed, or the session closed by clicking the CANCEL button and exit the 'Run a program' dialogue.

4.2.3   Starting Postresp from Manager Command Line or Journal File.

Click the toggle command button ⌗ and switch to the command line mode, see Section 4.6. The command line area appears in the dialogue window along with a list of main commands, see Figure 4.4. Enter appropriate commands by clicking in the command list, or type commands directly in the command line. Postresp is started by entering 'Run', 'POSTRESP' and Command Input File (optional).
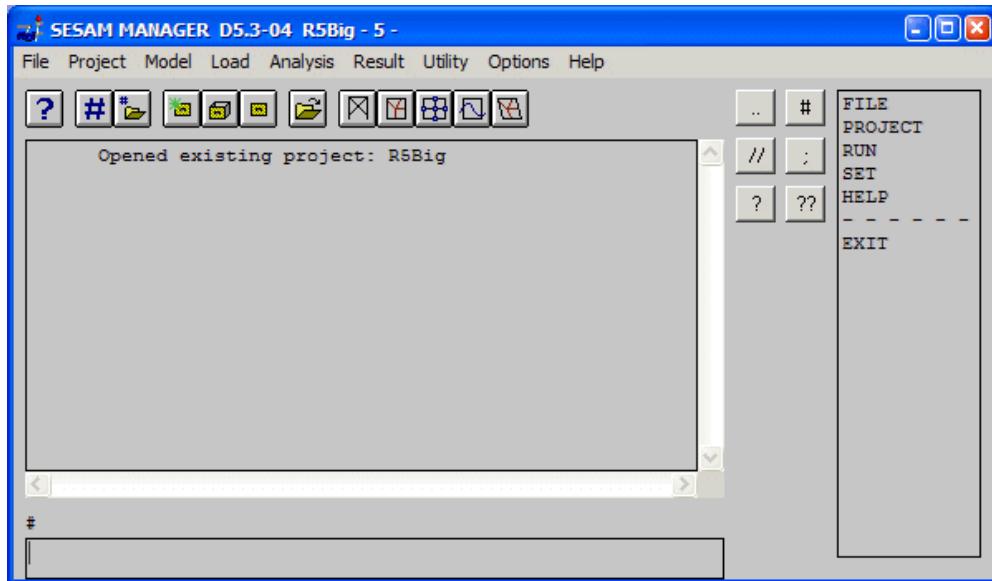
Figure 4.4   Command line mode dialogue of Manager

4.2.4   Starting Postresp in Graphics Mode

When started from Manager, the main Postresp will be as shown in Figure 4.5.
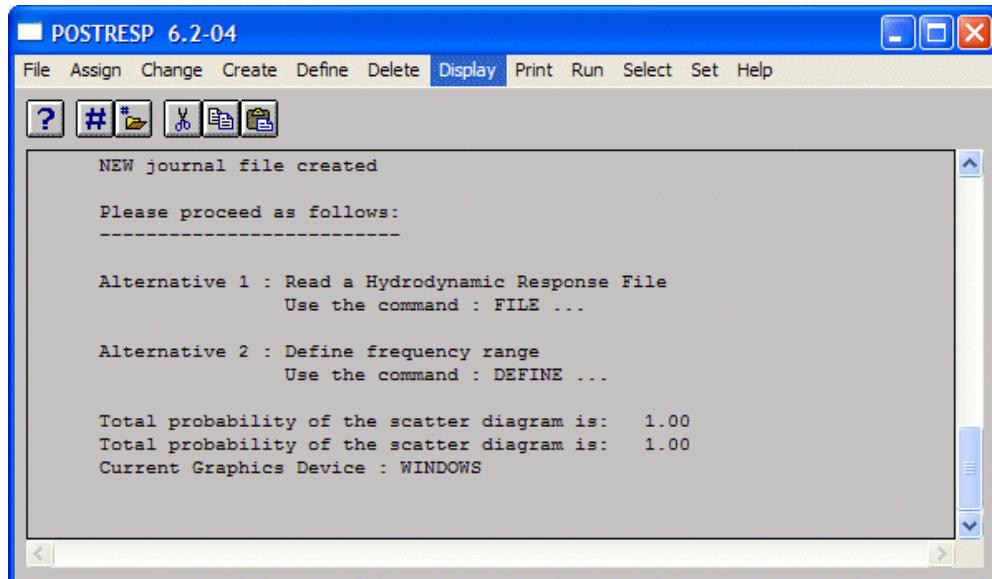
Figure 4.5   The main Postresp window

When started from outside Manager, with no input command file, the Postresp startup window will be as shown in Figure 4.6.
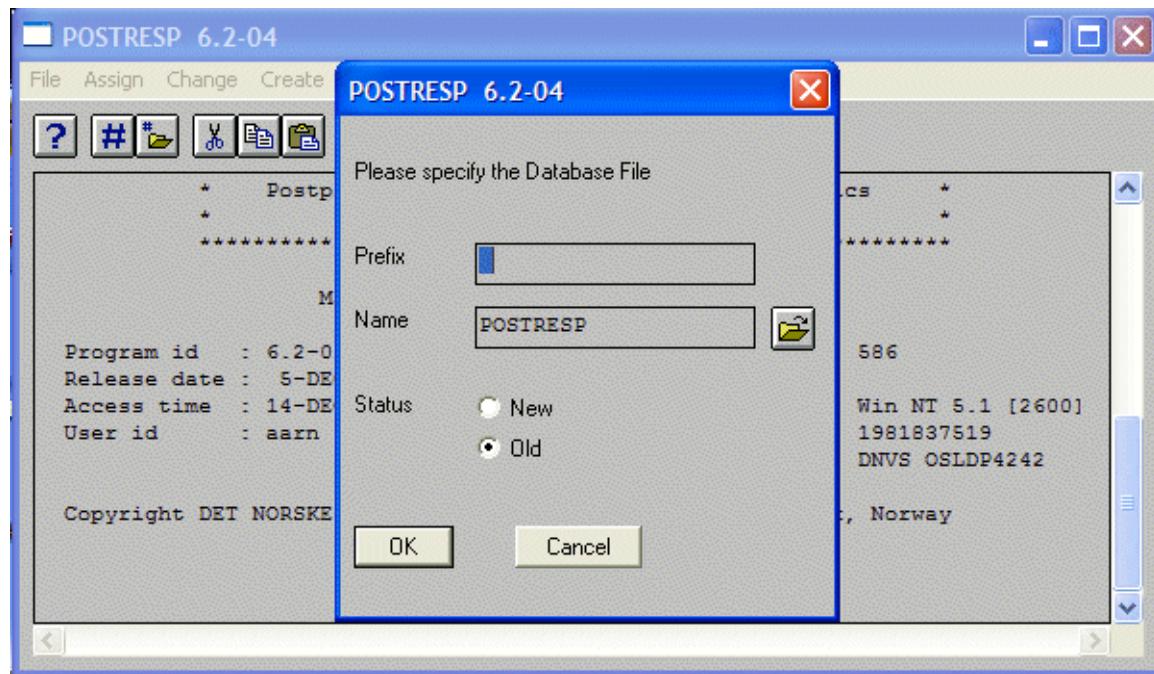
Figure 4.6   Postresp startup in graphics mode

Postresp can now be operated as described in section 3.1 and 3.2.

To exit the program, choose the Exit option under the File menu. Postresp will then close all open files and exit.

4.2.5   Starting Postresp in Line Mode on Unix

A line mode session will not give access to the graphics mode capabilities. The program runs in the terminal (window), and commands are typed on the input line.

There are two ways to start Postresp in line mode. The Motif version can be run in line mode by adding -l or -line or -L or -LINE after the program name.

```
prompt> postresp -l
```

When Postresp starts, it will give a heading first, then prompt for a database file prefix, name and status. This is how it appears with a new database:

```
     ******      ******      ******      ******     ** ***  ****
    ********    ********    ********    ********    *************
  **      **  **      **  **      **  **      **    **    **    **
  **          **      **  **                  **    **    **    **
  *******     **********  *******     *********     **    **    **
   *******    *********    *******    **********    **    **    **
        **    **                **    **      **    **    **    **
  **      **  **      **  **      **  **      **    **    **    **
   ********    ********    ********    *********     **    **    **
    ******      ******      ******     ****** **    **    **    **


        ********************************************************
        *                                                      *
        *                 P O S T R E S P                      *
        *                                                      *
        *    Postprocessor for General Response Statistics     *
        *                                                      *
        ********************************************************
                  Marketing and Support by DNV Sesam
 Program id   : V.N-XY                    Computer          :xxxxxx
 Release date : DD-MMM-YYYY               Impl. update    : None
 Access time  : DD-MMM-YYYY HH:MM:SS      Operating system : xxxxxx
 User id      : xxxxx                     CPU id           : xxxxxx
 Account      : xxxxx                     Installation     : xxxxxx
 Special notes for this program version :
    Graphics for VAXSTATION-UIS and X-WINDOW included
 Copyright DET NORSKE VERITAS SESAM AS, P.O.Box 300, N-1322 Hovik, Norway
 Database File Prefix? / /
 Database File Name? / POSTRESP/
 Database File Status? /OLD/
 #
```

If opening an existing database file (OLD), Postresp will in addition give some information about the contents of the database, or, if opening a new database file (NEW), give some guidelines on how to proceed.

This startup has opened a new database file, called POSTRESP.MOD and a new journal file, called Postresp.JNL (this session is running on a VAX).

If the file specification is somehow incorrect, Postresp will reissue the prompt for the database file prefix.

Typing a double dot (..) during the startup phase will abort the program.

The facilities that are available in line mode are described in Section 4.6.

To exit the program, type the EXIT command. This will close all files and exit the program.

4.2.6   Starting Postresp in a Batch Run

Postresp must be run in line mode during a batch run. It is recommended to prepare an input file first.

The batch command file can look like this:

```
prompt> postresp /status=new /interface=line /command='filename' /forced-exit
```

This command will start Postresp and establish a new database (/status=new), run the program in line mode (/interface=line), use command input defined on file 'filename' (/command='filename') and exit the program after executing the input commands (/forced-exit). The referred input file must be a text (ASCII) file with file extension .JNL, containing the Postresp input commands.

On a Unix system the user may also create a similar command input file e.g. POSTRESP_IN.JNL, and then issue the command below in order to execute Postresp as a background process

```
postresp /sta=new /interface=line < POSTRESP_IN.JNL > POSTRESP.LOG &
```

Alternatively, if the three first lines of the input file (myinput.inp) contains the following input:

```
' '
POSTRESP
NEW
```

followed by ordinary line commands, then the following commands will start Postresp and process the input:

On Windows:

```
prompt> postresp -l < myinput.inp
```

On Unix:

```
prompt> postresp -l < myinput.inp > myinput.log &
```

The header and messages generated by Postresp are sent to the logfile.

4.2.7   Files and Data Safety

Postresp uses the following files:

Database   The database file is a direct access file that is used to keep the model and analysis results. It has the extension: ".mod".

Journal   The journal file is used to keep a log of most of the commands that are accepted during a Postresp session. If an existing (OLD) database is opened, the journal will be appended to the corresponding old journal file if this exists. The journal file has the extension ".jnl".

Results Interface   The Sesam Hydrodynamic Results Interface File is normally used for transferring data from hydrodynamic analysis programs. Doing this, the file will consist of transfer functions for different global results and will be used in the frequency domain part of Postresp. This file may also be created by other programs, in that case note that there are some records in this file which are mandatory, such as WGLOBDEF, WBODCON and WDRESREF.

The Results Interface File may, in frequency domain be of any format, FORMATTED, UNFORMATTED or DIRECT ACCESS (often named SIN-file). In time domain, it is required that the Results Interface File is given on DIRECT ACCESS format.

If the file contains time series, the time domain extension of Postresp must be used (described in a separate user manual).

Command Input   This file is used to read commands and data into Postresp. The usage of command input files is described in Section 4.6.2. The default extension of a command input file is '.jnl', but this default is not used if another extension is specified.

Print   The print file is used to keep output from the PRINT command when the print destination is set to file. The extension of the print file is ".lis". The print file name and settings is specified using the command: SET PRINT. It is possible to use more than one print file during the same Postresp session, but only one can be open at a time.

Plot   The plot file is used to keep output from the PLOT command and from the DISPLAY command when the display destination is set to file. The plot file name and settings is specified using the command: SET PLOT. The extension of the plot file depends on the plot format used. Several formats are available, including Postscript. It is possible to use more than one plot file during the same Postresp session, but only one can be open at a time.

Postresp has been designed to protect the user against loss of valuable data. Thus, for some of the errors that may occur, Postresp will close the database file before exiting the program. It is however not always possible to catch a program crash and close the database file properly when it happens.

If the database file has been corrupted, the information may be reconstructed by use of the journal file. It is therefore recommended to take good care of the journal files, include comments etc. It can also be a good idea to take backup copies of the journal and database file at regular intervals.

4.3   Program Requirements

4.3.1   Execution Time

The execution time depends on which commands the user gives, and cannot be generalized. The Create Long Term Response command is the most time consuming, and the user should be careful about requesting long term responses calculated for all responses at the same time.

4.3.2   Storage Space

The initial size of the database ahead of any definitions or reading a Results Interface File is about 250 Kilobytes. For a small to a medium size run, the database may grow to 1 Mbyte. Huge runs can require up to 3 Mbyte storage space.

4.4   Program Limitations

There are certain program limitations with respect to some of the input parameters. These limitations may be listed during execution by using the PRINT LIMITATIONS command. Currently the limitations are:

— Maximum number of wave directions is 360

— Maximum number of frequencies is 201

— Maximum number of sections with sectional loads is 100

— *Maximum number of responses is 2000*

— Maximum number of zero upcrossing periods for short term response calculation is 25

— Maximum number of zero upcrossing periods for long term response calculation is 25

— Maximum number of significant wave heights for long term response calculation is 25

— Maximum number of zero upcrossing periods combined with different wave shapes used in long term response calculation is 75

— Maximum Number of Points forming a graph is 500

— Maximum Length of Variable Name is 8

— Maximum Length of User given text strings is 50

— Maximum number of frequency pairs for QTFs is 50x50

— All response variables read from the Results Interface File are assumed to have same and equally spaced wave directions.

— It is required in short crested sea calculations to have the wave directions in the area from 0 degrees to 360 degrees and the sequence of the wave directions must be in increasing order. If Postresp does not find a certain wave direction it will use the direction in the opposite, i.e. + or - 180 degrees. This is correct as long as the structure does not have any forward speed and as long as the phase information is of no interest.

4.5   Details on Graphics Mode

4.5.1   Graphics Environment

The Postresp graphics environment offers a main window with the following parts (from top to bottom):

Title bar	This gives the name and version of the program that is being run.
Main menu	This bar of pull-down menus gives access to all the commands of Postresp.
Shortcut buttons	This gives access to general tools, described below.
Message area	This is used to display messages and information, plus the commands that have been typed into the command input line, as well as those that have been read from command input files.
Command input line	This line is used to type line mode commands. All facilities that are described in Section 4.6 are available through this line. It is initialised by the # shortcut button.
Display area	This area is used to display graphs and other graphic information.

The shortcut buttons are as follows:

— Prints status list for Postresp. The status list is logged on the print file status.mlg

— Toggles command input mode on and off.

— Reads command input file. The file must have the extension .jnl.

— Cuts selected text to the clipboard.

— Copies selected text to the clipboard.

— Pastes text from the clipboard.
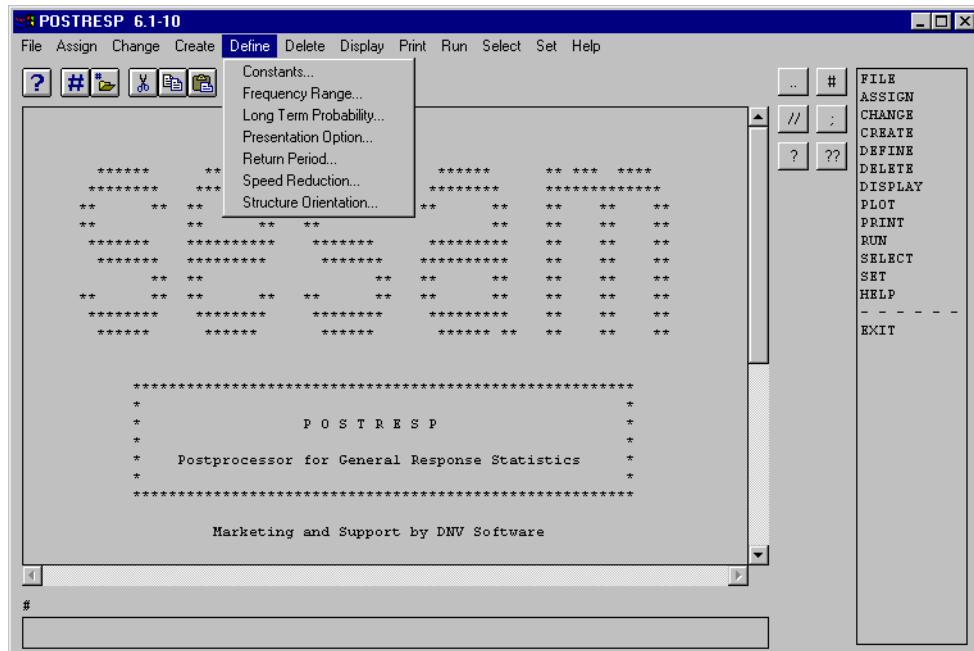
Figure 4.7   The Postresp graphics environment

If the main window is iconised, all the open dialogue boxes disappear into the icon. They pop up again when the main window is popped up. In addition to this, the graphics environment consists of:

Pull-down menus	These are pulled down from the items in the main menu. They are activated by clicking on an item in the main menu with the left mouse button, or by holding the left mouse button down on an item in the main menu. Similarly, some of the items in a pulldown menu may have a submenu sliding sidewards from the parent menu. To select an item in a pulldown menu, click on it or drag the mouse pointer to the item and release the button.
Dialogue boxes	Much of the user interaction will happen through dialogue boxes. Those items in the pulldown menus that have three dots following the item label all open a dialogue box when selected. The dialogue box is described more fully in Section 4.5.3
Print window	After the first Print command has been issued, a print window will pop up. This is a scrollable window, that contains all the output from the Print command that is directed to the screen. The window has a limited buffer, so if a single print command generates excessive amounts of print, some of it may disappear out of the top of the window. The print window may be iconised separately from the main window. It is possible to print inside an iconised print window. It does however not pop up automatically from an iconised state when something is printed.
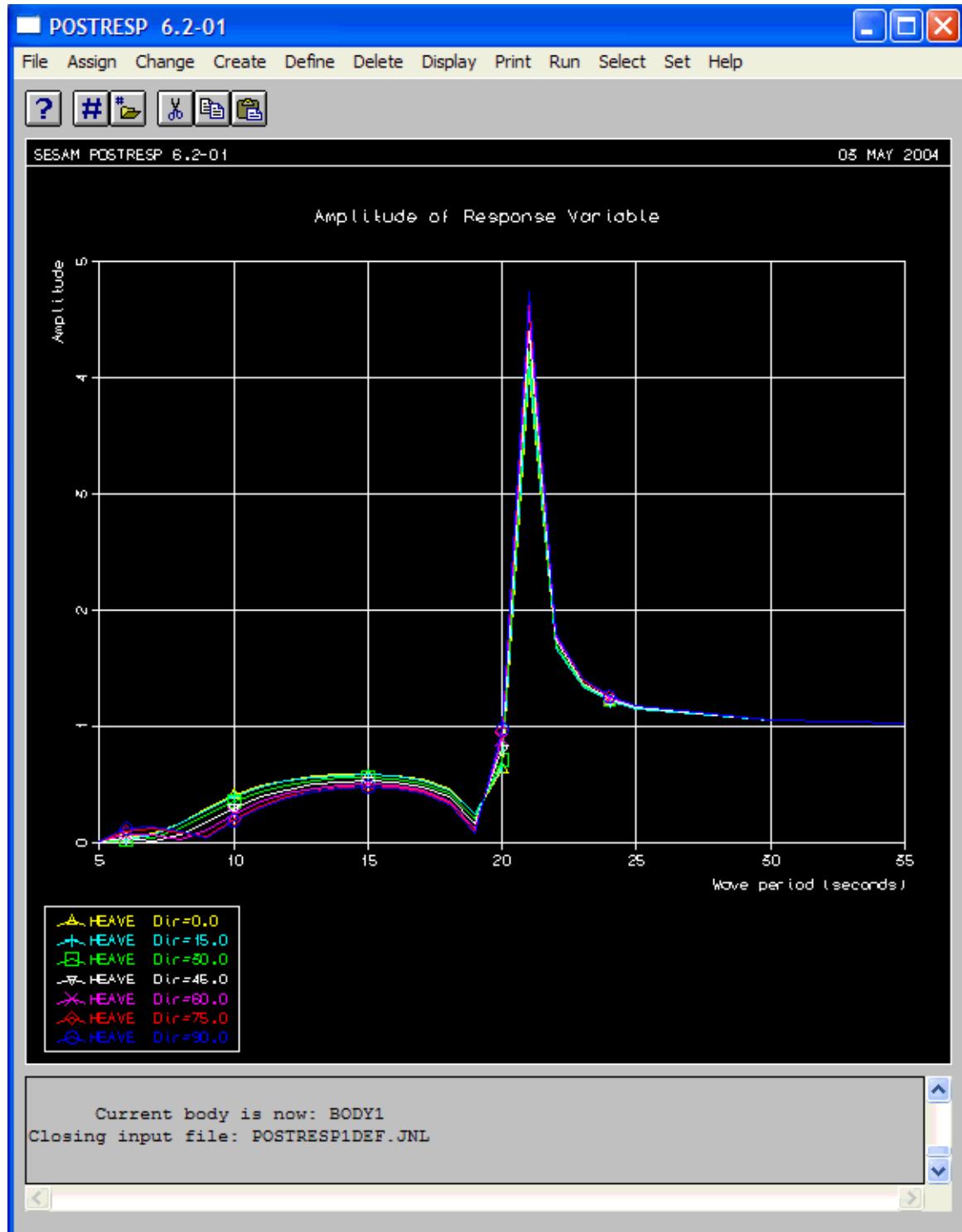
Figure 4.8   Main window with graphics area

4.5.2 How to get help

When inside a dialogue box, it is possible to get help on the item that currently has the input focus, by pressing the Help key (**F1** on most systems where there is no help key).

The help text will appear in the message area.

There is also a Help menu under the main menu, which contains much useful on-line information.

4.5.3 Dialogue Boxes and their Contents

A dialogue box is used to pass information from the user to Postresp. Most dialogue boxes also present the current defaults, and thus may be used to pass information from Postresp to the user.

The typical entries in a dialogue box are: **Input fields, Menus and Push buttons**.
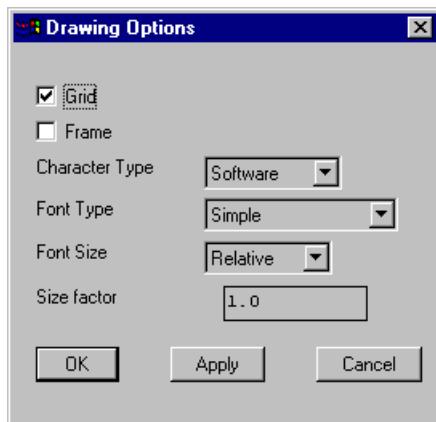
Figure 4.9   The Set Drawing dialogue box

An **input field** can contain a text, a name, an integer value or a numerical value. The Create Wave Spectrum dialogue box contains two input fields: the name and the description. To type into the field, click in it first using the left mouse button. In some input fields, the text can be longer than the width of the field as shown in the dialogue box. The text will then scroll if typed beyond the width of the input field.
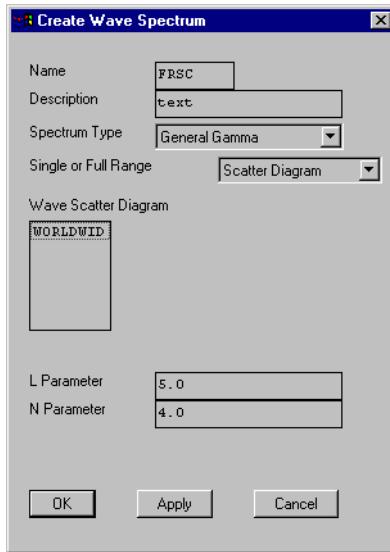
Figure 4.10   The Create Wave Spectrum dialogue box

Menus come in four different types: **Toggle buttons, Radio boxes, Option menus** and **Scrollable lists**. Selecting in a menu may cause changes in the layout of the dialogue box. This will depend on the dialogue box in use.

A **toggle button** is a button that has two states: On and Off. Two examples are given in the Set Drawing box, where the Frame button is Off and the Grid button is On. Click on the button or on the corresponding label to switch the status of the button.

A **radio box** is a collection of toggle buttons, where only one of the buttons can be active at any one time. All buttons are visible on the screen simultaneously. Click on a button or on the corresponding label to select that button.

An **option menu** is similar to a radio box, in that it presents a number of alternatives, of which only one is active at any one time. It is however operated differently. Click on the menu (not the corresponding label) to bring up the list of alternatives. Then click on an alternative to select it. Alternatively, click on the menu and hold the button down, then move the mouse pointer through the menu to the selected value, and then release the mouse button. The Spectrum Type menu in the Create Wave Spectrum box is an example of an option menu.

A **scrollable list** is a list of alternatives that is presented in a scrollable box. Such a menu is used in order to preserve space, or because the items in the list cannot be predicted before the menu is used. Use the scroll-bar to manoeuvre through the list, and select a value by clicking on it. Only one value can be selected at any one time. The Scatter Diagram list in the Create Wave Spectrum box is an example of a scrollable list.

A **push button** is a button that causes an action to happen when it is clicked on. OK, Apply and Cancel buttons are represented in the two boxes shown above. All dialogue boxes have a standard set of buttons at the bottom of the box. These buttons are described in the Section 4.5.4. If the label of a pushbutton is followed by three dots, the button will open a new dialogue box.

In addition to these items, there are a few more complex input items, that are described in Section 4.5.5 and Section 4.5.6. All relevant dialogue boxes are shown in Appendix C

4.5.4   The standard Buttons in a Dialogue Box

A dialogue box will contain one or more of these standard buttons, placed at the bottom of the box:

OK   Accept the contents of the box and close the box. The box will not be closed if there is an error in the information inside the box.

Apply   Accept the contents of the box. The box is not closed.

Cancel   Close the box without accepting the contents (or after having clicked Apply).

All dialogue boxes have a default push button that is activated by typing Return when the dialogue box is active. This push button is the OK or the Apply button. The default button will be highlighted or framed.

4.5.5   Selecting several Alternatives from a List

In e.g. the PRINT RESPONSE-VARIABLE command, a scrollable list of all response variables is presented. Any number of response variables can be selected from this list for print. Selected values are marked by highlighting.
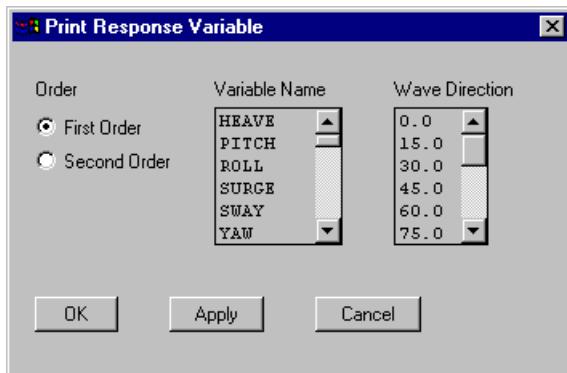
Figure 4.11   The Print Response Variable dialogue box

The basic way to select values is to click on a value, and then drag the mouse through the list. All values that the mouse pointer is dragged through are selected, and any previously selected value becomes unselected. To modify an existing selection, hold the Control key down while clicking in the list or dragging the mouse pointer through the list. All items that are clicked on while the Control key is held will reverse their selection status.

4.5.6   Entering a Vector or Matrix of Values

In many cases a vector or matrix of values must be input. Examples are entering return periods or creating a general combination of response variables.

The Create Response Variable dialogue box
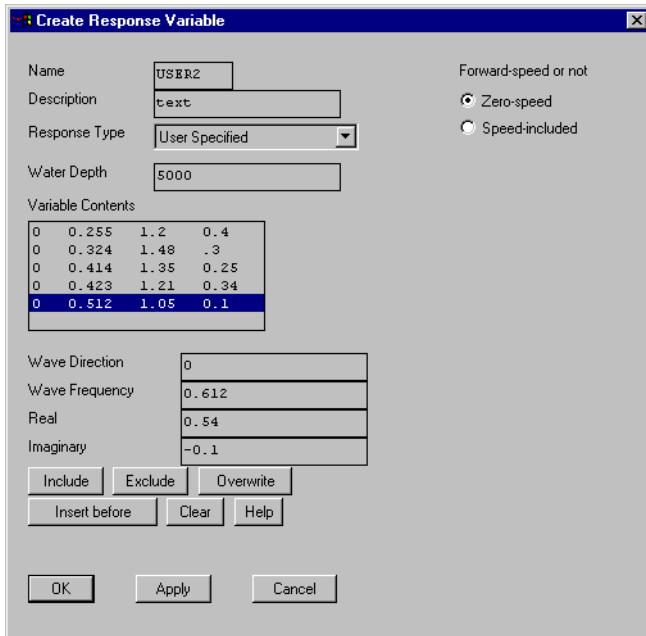
Figure 4.12   The Create Response Variable dialogue box

The graphics mode input of this is quite flexible. The values are presented in columns in a scrollable box. Under the box is one input field for each column in the matrix (one field if it is a vector). Under the input field(s) are two rows of buttons, that are used to manipulate the contents of the box.

Type values into the input fields, and hit <Return> in the last (bottom) field. The values are then inserted at the bottom, or before the selected row, or will over write the selected row, depending on the default status. The initial status is Include, which inserts values at the bottom. The input fields are cleared after the insertion is complete.

Instead of pressing <Return>, a button may be pressed. The effect of this is:

Include   Include the values in the input field(s) at the bottom, then clear the input fields. Set the default status to Include.

Exclude   Exclude all selected rows from the matrix/vector. The selection process is identical to the selection described in Section 4.5.5. Set the default status to Include.

Overwrite   Overwrite the selected row with the contents of the input fields. Only one row can be selected in the scrollable box. The next row (if any) will then be selected, and the default status will be set to Overwrite. The input fields will be cleared.

Insert before   Insert the contents of the input fields before the selected row. Only one row can be selected in the scrollable box. The default status will be set to "Insert before". The input fields will be cleared.

Clear   Clear the contents of the matrix. Note that there is no way to get the cleared contents back, other than perhaps cancelling the dialogue box and opening it again.

Help   Pressing this is equivalent to pressing the help button while the scrollable box has the input focus. It provides on-line access to a description of how to use the matrix/vector.

4.5.7   Journalling from Graphics Mode

All commands that are accepted from the graphics mode are logged on the journal file. The commands are logged in a format that can be read into the corresponding line mode command.

There is one case that deserves attention:

Some dialogue boxes contain many line mode commands. An example is the Define Presentation Option dialogue box. Since all the visible contents of a dialogue box are selected when the OK or Apply button is pressed, even if only parts of the box has been changed, all possible commands in the box will be logged.
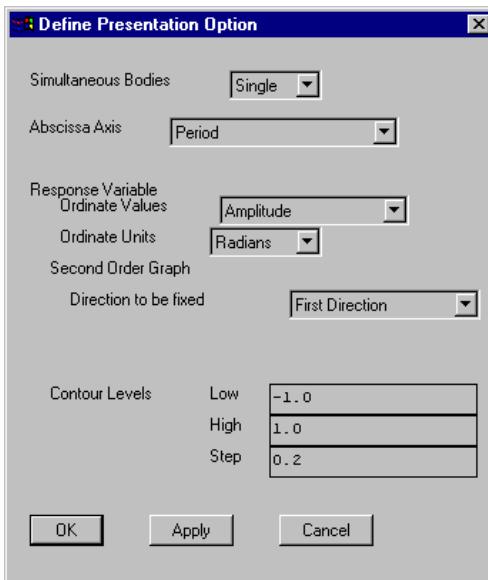
Figure 4.13   The Define Presentation Option dialogue box

Pressing the OK or Apply button in this box will generate the following log:

```
DEFINE PRESENTATION-OPTION SIMULTANEOUS-BODIES SINGLE
DEFINE PRESENTATION-OPTION ABSCISSA-AXIS PERIOD
DEFINE PRESENTATION-OPTION RESPONSE-VAR ORDINATE-VALUES AMPLITUDE
DEFINE PRESENTATION-OPTION RESPONSE-VARIABLE ORDINATE-UNITS RADIANS
DEFINE PRESENTATION-OPTION RESP-VAR SECOND-ORDER-GRAPH FIRST-DIRECTION
DEFINE PRESENTATION-OPTION RESPONSE-VARIABLE CONTOUR-LEVELS -1.0 1.0 0.2
```

4.6   Using Postresp in Line Mode

The line mode environment in Postresp is very powerful. It has many features and provides a great flexibility to the user. This section describes the facilities one by one. Even when running graphics mode, the line mode environment is available through the command input line.

There are two modes of operation inside the line mode environment, called *command mode* and *programming mode*.

Command mode is the commonly used mode, it is used to give commands to Postresp. A new input line always starts in command mode. To switch to/from programming mode inside an input line, type the dollar sign: $.

Programming mode is used basically to calculate numerical values. These values can then be used in a command if desired, or they can be viewed as results. Programming mode is described in detail in Section 4.6.3

When moving through the commands, Postresp will present a prompt, possibly followed by a default in / /. The main command level is signified by the prompt: **#.**

No default is presented here. The main commands are ASSIGN, CHANGE, CREATE etc. These are described in Chapter 5. When moving inside a command the prompt will change and a default may be presented.

Different items on the command line are separated by blank spaces, except if it is text that is protected inside quotes. In special cases, the blank space may be left out. Such cases are documented in the sections below.

Postresp does not require line breaks anywhere, except for a few cases in programming mode (these are described in Section 4.6.3). Thus several commands can be typed into the same command input line. This is however not recommended as it easy to lose oversight in such a case.

In the following, input typed by the user is shown in bold, while prompts given by Postresp are shown as ordinary text.

4.6.1   How to get help

Context sensitive help is available in command mode at any time using any of these methods:

Type: **?**   to get a brief description of what Postresp is expecting right now.

Type: **text?**   during a selection between alternatives to see all the alternatives that match text. text may contain wildcards or be an abbreviation.

Type: **??**   to get a more descriptive help text, showing how to proceed.

There is also a HELP menu under the main menu, giving on-line access to the items that are described here.

Inside programming mode the question mark may be used to get information:

Type: **? symbol**   to get the syntax of a function or procedure, or to see the value of a variable or a predefined constant. **symbol** is the name of the function, procedure, variable or constant.

Type **? expression**   to see the value of **expression** (a calculated numerical expression). Note that it is necessary to type the question mark before the expression in order to see the value, otherwise the value is just passed on to the current command.

The keyword **show** may be used in programming mode instead of the question mark with the same effect.

4.6.2   Command Input Files

Line mode commands may be read from a file as well as typed directly into Postresp. Such a file may contain any syntax that is allowed in line mode, including reading another command input file.

To read in a command input file, type an **@** followed by the filename. To read parts of the file, specify the number of lines to read after the filename. If the filename does not have an extension (i.e. a dot and the following part), Postresp adds .jnl to the name.

Postresp may have more than one command input file open at one time. It will always read the files sequentially, finishing the last opened file first. To get a list of the currently open files, type: **@?**

The last opened command input file may be closed explicitly by typing the @ followed by two dots: **@..**

When a command input file is being read, the lines read are echoed on the screen and logged in the journal file. Programming expressions are logged as comments and the resulting values are logged as part of the command. The @ command itself is not logged on the journal file.

If an error is found inside a command input file, Postresp stops reading the file and skips the remaining part of the line where the error was found.

Postresp will also stop reading a command input file if it finds a line containing only an @.

The commands used to manipulate command input files are summarized below.

@filename   Read the named file from the top. Reading will stop if an error is found, or at the end of the file, or if a line with only an @ is found. There may be one or more blank spaces between @ and the filename.

@filename n   Read **n** lines from the starting of the named file. Reading will stop if an error is found, or if a line with only an @ is found. There may be one or more blank spaces between @ and the filename.

@   Continue reading the presently open file. Reading will stop if an error is found, or at the end of the file, or if a line with only an @ is found.

@ n   Continue reading n lines from the presently open file. Reading will stop if an error is found, or at the end of the file, or if a line with only an @ is found.

@..   Close the last opened command input file. There cannot be any blank space between @ and the dots.

@?   Show the name and status of the currently open command input file(s).

4.6.3 The built-in Calculator

Postresp has a fully equipped calculator, that allows for on-line calculation of numerical expressions. The calculator has:

- Numerical expressions using parentheses and the standard operators: + - * and ** (exponentiation)

- Variables containing numerical values can be defined and reused.

- Built-in constants, functions and procedures.

To enter programming mode, use the dollar sign: **$**. It must be preceded by a blank space if it is not the first character entered.

To leave programming mode again, finish the input line or type another $ followed by a blank space.

Variables are assigned a value simply by using the syntax:

$ name = expression

where **name** is the name of the variable and **expression** is a numerical expression. Variable names must start with a letter (a-z or A-Z). Any following character can be alphanumeric or an underscore.

Variables and predefined constants are used by typing their name in place of a numerical value inside a numerical expression. The value of the variable or constant is substituted for the name when the value of the expression is calculated.

The command **HELP PROGRAMMING-MODE** gives on-line access to the information supplied here.

HELP PROGRAMMING-MODE VARIABLES gives a list of all the variables that are currently defined.

HELP PROGRAMMING-MODE BUILT-IN gives a list of all built-in constants, functions and procedures. The question mark may be used to examine any one of these. The predefined constants include PI and E. The list of functions is extensive.

Examples of programming mode usage:

 # CREATE SPECIFIC-POINT SP1 'text' 10. 0. $ 20./3.0

$? log

 log(x) : natural logarithm

$ x = log(10)

$ y = 2*(x+sin(0.44)) – (mi exp(x/1.54)

$ show y

 y = 0.9968869507 is a variable

$? normaldist

normaldist(x,mean,stdv) : Distribution function for Normal distribution

$ show normaldist(2,0,1)

 0.977249938

There are two special cases that deserve attention.

•   Do not use a variable immediately after it is assigned.

    This will not work: **$ x = exp(3.2) y = x+2**

    The reason is that Postresp interprets the complete programming expression before the value is assigned to x, thus x has no value when it is being used. The solution is to either insert two dollars between the assignment and the usage (leaving and entering programming mode), or go to a new input line after the assignment.

•   Postresp puts any default numerical value into a variable called *default*, so that it may be modified and reused. However, when using this value, the usage of the value must be the first item on the input line. The reason for this is that Postresp interprets the complete input line when it is read, and the default variable is not assigned its value until at the point where the default is becoming active.

    This will not work: # **DEFINE CONSTANT GRAVITY $ default*0.5**

    because the default does not exist when the command line is interpreted.

    This will work:

    # **DEFINE CONSTANT GRAVITY**

    $ default*0.5

Everything typed in programming mode will be logged as a comment. If the program produces a numerical value that is used in a command, the numerical value will be logged as part of the command after the programming expression has been logged as a comment.

4.6.4   Accessing default Values

Postresp will in many cases supply a default value when input is requested. The default will be presented in / /. An example:

DEFINE CONSTANT GRAVITY

Gravity? /9.81/

The default may be accepted using one of the following methods:

Type: <**Return**>   (i.e. an empty input line) to accept the current default.

Type: **:** (colon)   to accept the current default. The colon must be preceded by a blank space if it is not the first item on the command line. However, several colons may follow each other without intervening spaces.

Type: **;** (semicolon)   to keep accepting defaults as long as they are presented, or until the command is complete. The semicolon must be preceded by a blank space if it is not the first item

on the command line. However, several semicolons may follow each other without intervening spaces.

Please note that an empty line in a command input file will not be interpreted as a default. The colon and semicolon may be written into a command input file.

A colon or semicolon is never logged on the journal file. Instead, the substituted default value(s) is logged.

When a numerical default is available, it will be stored in the calculator as a variable under the name default, so that it may easily be modified. See the note at the end of Section 4.6.3 about this.

4.6.5   Abbreviation and Wildcards

Postresp offers two methods to shortcut selection of elements in a list: Abbreviation and the use of wildcards.

Abbreviation of alternatives up to hyphens is allowed, as long as the abbreviation is unique. Thus, LONG-TERM-RESPONSE may be abbreviated to any of: LONG, L-T-R, L-TERM-RES, L, L--RES as long as the abbreviation is unique between the alternatives presented.

Wildcards consist of the following two characters:

*   substitutes for any number of characters. It also matches nothing.

&   substitutes for any one character. It must match exactly one character.

As an example, x*y&&1 matches xabycc1 and xy111 but not xaby11.

Abbreviation and wildcards may not be mixed in the same matching expression. For example, *-RESP will not match LONG-TERM-RESPONSE.

4.6.6   Input of a Text or Name or Numerical Value

Numerical values can be input in free format in Postresp. Floating point numbers as: 1000 1. .54 1e-44 .1e5 are all accepted.

Integers can be specified as floating point numbers, as long as the decimal part vanishes. Examples of whole numbers: 1000 1. .1e4

Names can be up to 12 characters long and may contain any alphanumeric character as well as the underscore (_) and the hyphen (-). A name must begin with an alphanumeric character. The input case of a name is preserved, but it is not of significance when comparing names at a later stage (e.g. the name: Span is considered to be identical to the name: span).

Text must be protected in single quotes: ' ' if it contains blank space(s) and/or special characters.

4.6.7   Selecting a single Alternative from a List

In many cases, Postresp will require a selection of a single alternative from a list. An example is at the main prompt # where the main commands are presented for selection. The selection needs not be between commands, it could also be between named objects or between numerical values.

In selection of a single value abbreviation is allowed (see Section 4.6.5), but wildcards cannot be used. An exact match is always preferred. Thus it is possible to select an item that is an abbreviation of another item in the list by typing the item exactly.

A single question mark: **?** will show all items in the list. Prefixing the question mark with a a text: **text?** will show all items in the list matching **text**.

The input text may be typed in upper or lower case as desired, Postresp disregards the case of the text when it does the comparison.

The input text used to make the selection is not logged on the journal file. Instead, the selected value is logged as it is presented in the list.

4.6.8   Selecting several Alternatives from a List

In some cases, a list of items is presented, from which one or more items can be selected. An example is the PRINT RESPONSE-VARIABLE command, where a number of response variables may be selected for print.

In this selection, both wildcards and abbreviation may be used (but not inside the same text).

The syntax for the selection allows for more flexibility then in the single selection case, because it may be of interest to keep modifying the selection for some time before accepting it. The selection process consists of one or more selection operations, each of which follow the syntax described below. If more than one operation is required to complete the selection, the selection must be enclosed in parenthesis: ( )

The syntax for a single selection operation is:

INCLUDE text   Include the item(s) matching **text** in the selection. Set the default status to IN-CLUDE. Any items specified after this will be included in the selection until the status is changed.

ONLY text   Set the current selection to only the item(s) matching **text**. Any previous selection is deselected first. Set the default status to INCLUDE. Any items specified after this will be included in the selection until the status is changed.

EXCLUDE text   Exclude the item(s) matching **text** from the selection. Set the default status to EX-CLUDE. Any items specified after this will be excluded from the selection until the status is changed.

text   Include or exclude the items matching **text**, depending on the default status. The initial default status is INCLUDE.

In the case of a selection of numerical values, or of a selection between names (which can be integer values), the **text** can be substituted with the interval expression:

GROUP from to step

which expands to the values: **from**, **from** + **step**, **from** + 2 * **step**, ...

up to but not exceeding **to**.

When a default selection is being presented, or if the left parenthesis has been typed as input, Postresp presents the right parenthesis as default: /)/ .

A single question mark: **?** will show all items in the list, listing the selected items in parenthesis. Prefixing the question mark with a text: **text?** will show all items in the list matching **text**.

Examples:

PRINT RESPONSE-VARIABLE *

will print all response variables.

PRINT RESPONSE-VARIABLE (* EXCLUDE SECL*)

will print all response variables except sectional loads named SECLnn.

4.6.9   Entering a Vector or Matrix of Values

The syntax for entering a vector or matrix of values is an extension of the syntax for selecting values from a list. In this case there is no fixed list to select from. Instead the items are inserted and manipulated as the vector/matrix is entered.

The term **vector** is used for the case where the input is one dimensional. An example of this is entering parameter values in the DEFINE RETURN-PERIOD command.

The term **matrix** is used for the case where the input is multidimensional. An example of this is the input of a user defined wave spectrum, where the frequencies and weights form a two dimensional matrix. Like a vector is built up from single items, a matrix is built from rows. All columns of a matrix must have the same number of items.

The input of a vector/matrix consists of one or more operations. If more than one operation is required (as it most likely will be), they must be enclosed in parenthesis.

The syntax of one operation is (**row** refers to a single value in a vector or to a row in a matrix):

INCLUDE row	Include the specified **row** as the last row. Set the default status to INCLUDE. Until the status is changed, rows that are entered will be added at the end.
EXCLUDE row	Exclude the specified **row**. Set the default status to EXCLUDE. The next row(s) that are entered will also be excluded until the default status is changed. Wildcards may be used to specify **row**. All matching rows will be excluded.

ONLY row	Include only **row** in the matrix, clearing any previous contents first. Set the default status to INCLUDE. Until the status is changed, rows that are entered will be added at the end.
INSERT-BEFORE row1 row2	Insert **row1** before **row2**. Set the default status to INSERT-BE-FORE. Until the status is changed, rows will be keep being inserted before **row1** (immediately after the last row entered). Wildcards may be used to specify **row1**, provided that one row is matched uniquely.
OVERWRITE row1 row2	Overwrite **row1** with **row2**. Set the default status to OVER-WRITE. The next row(s) that are entered will continue overwriting until the default status is changed, scrolling down as they do so. When the last row has been overwritten, the default status is changed to INCLUDE. Wildcards may be used to specify **row1**, provided that one row is matched uniquely.
LIST	List the contents of the matrix.
row	Insert, Exclude or overwrite, using **row**, depending on the default status. The initial default status is INCLUDE.

In the case of a one dimensional vector containing numerical values or names (which can be integer values), **row** or **row2** can be substituted with the interval expression:

GROUP from to step

which expands to the values: **from**, **from** + **step**, **from** + 2 * **step**, ...

up to but not exceeding **to**.

When a default vector/matrix is being presented, or if the left parenthesis has been typed as input, Postresp presents the right parenthesis as default: /) / .

A single question mark will show the possible alternatives in the matrix.

Use LIST to see the rows in the matrix.

Examples:

DEFINE RETURN-PERIOD GROUP 10 50 10

will define return periods to be used in long term response calculation as 10, 20, 30, 40 and 50.

CREATE WAVE-SPECTRUM USER-SPECIFIED TESTSPEC ' '

(0.1 1. 0.2 1. 0.3 1. 0.4 1. 0.5 1. 0.6 1. 0.7 1. 0.8 1. 0.9 1. 1.0 1.)

Creates a constant wave spectrum defined in the angular frequency area of 0.1 to 1.0.

4.6.10   Setting and clearing Loops in a Command

When a command is completed, Postresp will by default go back to the main prompt: # . If a command is to be repeated many times in slightly different versions, it can be desirable to go back to an intermediate level instead of to the main prompt. This is accomplished by typing the text: **LOOP** at the point where the command is to be repeated. The loop is removed by typing **END** at the loop point, or by aborting the command using the double dot (..).

An obvious example in Postresp is in the CREATE RESPONSE-SPECTRUM command. Often, many spectra are created in sequence in order to get control of the identification numbers. It then makes sense to set a loop just after CREATE RESPONSE-SPECTRUM. In the example below, 3 response variables, 3 wave directions and all wave spectra is selected. The n first response spectra will be for long crested sea, and the n to 2*n for short crested sea using a wave energy spreading function named COS2.

```
CREATE RESPONSE-SPECTRUM
LOOP
     SURGE   ( 0 45 90 )   * NONE
     SURGE   ( 0 45 90 )   * COS2
     SWAY    ( 0 45 90 )   * NONE
     SWAY    ( 0 45 90 )   * COS2
     HEAVE   ( 0 45 90 )   * NONE
     HEAVE   ( 0 45 90 )   * COS2
END
```

4.6.11   Inserting a Command into another Command

It is possible to insert a command at any point while in command mode (not in programming mode). This is done by simply typing the main prompt: # followed by the inserted command.

Postresp will finish the new command, and then return to the point in the previous command, where the new command was inserted.

This is useful e.g. for catching up on settings or definitions that was forgotten while inside a PRINT or DISPLAY command, or for printing out objects to see what they contain. The following examples illustrate this:

DISPLAY RESPONSE-VARIABLE # DEFINE PRESENTATION-OPTION

Define Presentation Option? **ABSCISSA-AXIS PERIOD**

Name? **HEAVE ***

The same command cannot be entered recursively, e.g. it is not allowed to insert a CHANGE RESPONSE-VARIABLE command inside another CHANGE RESPONSE-VARIABLE command.

Commands can be nested this way to as many levels as desired. However, to nest with more than one level may be confusing and is not recommended. The current status may be seen by typing: **-?**. This facility is described in Section 4.6.14.

4.6.12   Aborting all or parts of a Command

To abort a command type two dots: **..** . Please note that all entries on the command line up to the double dot will be processed before the command is aborted.

The double dot clears all loops and previous input in the command and then presents the main prompt: # .

A double dot is not logged, except for one case: If it is used after an inserted command has been completed. The reason is, that the completion of the inserted command causes the first part of the command to be logged before the inserted command. It is therefore necessary to log the double dot in this case, so that the log file will have a correct syntax.

To abort parts of a command, going back to the last LOOP or to the point of a left parenthesis in a multiple selection or a vector or a matrix, type: <<< .

CtrlC may also be used to abort a command (hold the Control key while typing C). Usage of CtrlC will throw away all of the input of the command line as well as abort the command. Unlike the double dot, the input before the CtrlC is not processed. CtrlC may also be used to abort a running analysis.

4.6.13   Access to the Operating system

It is possible to issue a command to the operating system at any point in a Postresp command (not from programming mode). This is done by typing an exclamation mark: ! followed by the operating system command. Everything on the input line after the exclamation mark is sent to the operating system.

This example, taking from a run on a VAX computer, will list all files matching postresp.*:

!dir postresp.*

This facility is very useful for obtaining directory listings, editing files (eg. input files), spawning into the operating system to do more complicated tasks, etc.

This facility is also available from the command input line in graphics mode, but, when used here the output from the operating system will appear in the terminal window from which Postresp was started.

4.6.14   Appending Input Lines

After receiving an input line, Postresp will process the input, unless told otherwise. The way to suspend processing of an input line is to type a backslash: \ as the last character in the line. Postresp will then issue the append prompt: >> .

An example:

CREATE SPECIFIC-POINT SP1 'Description of point SP1' \

>> 10. 0. -2.3

4.6.15 Viewing the current Status of a Command

Some commands are long, and it may be difficult to keep track of what has actually been given as input. In other cases where commands have been inserted, it is desirable to see what the current command(s) actually look like to Postresp. For this reason, the command: **-?** has been introduced. A few examples is the best way to show what it does.

DISPLAY RESPONSE-VARIABLE # DEFINE PRESENTATION-OPTION

Define Presentation Option? **-?**

DISPLAY RESPONSE-VARIABLE

DEFINE PRESENTATION-OPTION

Define Presentation Option? **ABSCISSA-AXIS PERIOD**

Name? **HEAVE ***

4.6.16 Comments

A comment may be typed anywhere in a command while in command mode (not in programming mode). Comments are prefixed by the percent sign: %. Everything from the percent sign to the end of the line is treated as a comment. A comment need not be the first item on a line.

Examples:

DEFINE PRESENTATION-OPTION ABSCISSA-AXIS PERIOD % change to period

% This is a comment.

5   COMMAND DESCRIPTION

The hierarchical structure of the line-mode commands and numerical data is documented in this chapter by use of tables. How to interpret these tables is explained below. Examples are used to illustrate how the command structure may diverge into multiple choices and converge to a single choice.

In the example below command A is followed by either of the commands B and C. Thereafter command D is given. Legal alternatives are, therefore, A B D and A C D.

A	B	D
	C	

In the example below command A is followed by three selections of either of commands B and C as indicated by *3. For example: A B B B, or: A B B C, or A C B C, etc.

A	B	*3
	C	

In the example below the three dots in the left-most column indicate that the command sequence is a continuation of a preceding command sequence. The single asterisk indicate that B and C may be given any number of times. Conclude this sequence by the command END. The three dots in the right-most column indicate that the command sequence is to be continued by another command sequence.

...	A	B	*	...
		C		
		END		

In the example below command A is followed by any number of repetitions of either of the sequences B D and C D. Note that a pair of braces ({ }) is used here merely to define a sequence that may be repeated. The braces are not commands themselves.

A	{	B	D	}*
		C		

The characters A, B, C and D in the examples above represent parameters being line-mode COMMANDS (written in upper case) and numbers (written in lower case). All numbers may be entered as real or integer values. Brackets ([ ]) are used to enclose optional parameters.

A parameter followed by a '+' signifies a selection of one or more numerical values, names or texts from a list of items. In line mode this selection must be enclosed by parentheses.

Note: **Line mode commands are in this chapter presented in upper case including hyphens. In graphics mode the commands appear in mixed case and without hyphens.**

Note: **Graphics mode commands that are irrelevant at a given time are masked out (shown grey in graphics mode).**

Note: **The command END is generally used to end repetitive entering of data. Using double dot (..) rather than END to terminate a command will, depending on at which level in the command it is given, save or discard the data entered. Generally, if the data entered up to the double dot is complete and self-contained the double dot will save the data. If in doubt, it is always safest to leave a command by entering the required number of END commands.**

Use of Postresp in graphics mode is described in Section 4.5. *Pull down menus and dialogue boxes of the graphic mode are shown in Appendix C.* Tutorial examples of line mode command input are given in Appendix A.

The HELP command is not described here. It is intended purely to serve as on-line help. Usage of the HELP command is not logged. When in doubt how to do things try the HELP command, or take a look at Section 4.5.2 and Section 4.6.1.

5.1 Commands for Postresp

The following chapter shows the syntax for the line mode commands in the frequency domain. The commands specific for the time domain are described in a separate user manual. The description of the commands is naturally valid for the commands in the graphic mode as well.

5.2 Frequency domain

```
ASSIGN
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION
ASSIGN WAVE-DIRECTION-PROBABILITY
ASSIGN WAVE-SPECTRUM-SHAPE
ASSIGN WAVE-SPREADING-FUNCTION
ASSIGN WAVE-STATISTICS

CHANGE
CHANGE LONG-TERM-FATIGUE
CHANGE LONG-TERM-RESPONSE
CHANGE MATRIX
CHANGE RESPONSE-VARIABLE
CHANGE SN-CURVE
CHANGE SPECIFIC-POINT
CHANGE WAVE-SPECTRUM
CHANGE WAVE-SPREADING-FUNCTION
CHANGE WAVE-SPREADING-FUNCTION COSINE-POWER
CHANGE WAVE-SPREADING-FUNCTION USER-SPECIFIED
```

```
CHANGE WAVE-STATISTICS

CREATE
CREATE LONG-TERM-FATIGUE
CREATE LONG-TERM-RESPONSE
CREATE RESPONSE-CO-SPECTRUM
CREATE RESPONSE-SPECTRUM
CREATE RESPONSE-VARIABLE
CREATE RESPONSE-VARIABLE COMBINED-MOTION
CREATE RESPONSE-VARIABLE FIRST-DERIVATED
CREATE RESPONSE-VARIABLE GENERAL-COMBINATION
CREATE RESPONSE-VARIABLE SECOND-DERIVATED
CREATE RESPONSE-VARIABLE USER-SPECIFIED
CREATE SHORT-TERM-RESPONSE
CREATE SN-CURVE
CREATE SPECIFIC-POINT
CREATE SPEED-REDUCTION-CURVE
CREATE WAVE-SPECTRUM
CREATE WAVE-SPECTRUM 2D-USER-SPECIFIED
CREATE WAVE-SPECTRUM GENERAL-GAMMA
CREATE WAVE-SPECTRUM ISSC
CREATE WAVE-SPECTRUM JONSWAP
CREATE WAVE-SPECTRUM OCHI-HUBBLE
CREATE WAVE-SPECTRUM PIERSON-MOSKOWITZ
CREATE WAVE-SPECTRUM TORSETHAUGEN
CREATE WAVE-SPECTRUM USER-SPECIFIED
CREATE WAVE-SPREADING-FUNCTION
CREATE WAVE-SPREADING-FUNCTION COSINE-POWER
CREATE WAVE-SPREADING-FUNCTION USER-SPECIFIED
CREATE WAVE-STATISTICS
CREATE WAVE-STATISTICS ISSC-SCATTER-DIAGRAM
CREATE WAVE-STATISTICS NORDENSTROM
CREATE WAVE-STATISTICS SCATTER-DIAGRAM
CREATE WORKABILITY-ANALYSIS

DEFINE
DEFINE CONSTANTS
DEFINE FREQUENCY-RANGE
DEFINE LONG-TERM-PROBABILITY
DEFINE PRESENTATION-OPTION
DEFINE RETURN-PERIOD
DEFINE SPEED-REDUCTION
DEFINE STRUCTURE-ORIENTATION

DELETE
DELETE LONG-TERM-FATIGUE
DELETE LONG-TERM-RESPONSE
DELETE RESPONSE-CO-SPECTRUM
DELETE RESPONSE-SPECTRUM
DELETE RESPONSE-VARIABLE
DELETE SHORT-TERM-RESPONSE
DELETE SN-CURVE
DELETE SPECIFIC-POINT
DELETE SPEED-REDUCTION-DATA
```

```
DELETE WAVE-SPECTRUM
DELETE WAVE-SPREADING-FUNCTION
DELETE WAVE-STATISTICS
DELETE WORKABILITY-ANALYSIS

DISPLAY
DISPLAY LONG-TERM-RESPONSE
DISPLAY MATRIX
DISPLAY REFRESH
DISPLAY RESPONSE-CO-SPECTRUM
DISPLAY RESPONSE-SPECTRUM
DISPLAY RESPONSE-VARIABLE
DISPLAY SECTIONAL-FORCE-DIAGRAM
DISPLAY SHORT-TERM-RESPONSE
DISPLAY SN-CURVE
DISPLAY SPECIFIC-POINT
DISPLAY SPEED-REDUCTION-CURVE
DISPLAY WAVE-SPECTRUM
DISPLAY WAVE-SPREADING-FUNCTION

FILE
FILE EXIT
FILE PLOT
FILE READ

HELP
HELP COMMAND-INPUT-FILE
HELP LINE-MODE
HELP PROGRAMMING-MODE
HELP STATUS-LIST
HELP SUPPORT

PLOT

PRINT
PRINT DATASET
PRINT LIMITATIONS
PRINT LONG-TERM-FATIGUE
PRINT LONG-TERM-RESPONSE
PRINT MATRIX
PRINT OVERVIEW
PRINT RESPONSE-CO-SPECTRUM
PRINT RESPONSE-SPECTRUM
PRINT RESPONSE-VARIABLE
PRINT SECOND-ORDER-STATISTICS
PRINT SHORT-TERM-FATIGUE
PRINT SHORT-TERM-RESPONSE
PRINT SHORT-TERM-STATISTICS
PRINT SN-CURVE
PRINT SPECIFIC-POINT
PRINT SPEED-REDUCTION
PRINT WAVE-SPECTRUM
PRINT WAVE-SPREADING-FUNCTION
PRINT WAVE-STATISTICS
PRINT WORKABILITY-ANALYSIS
```

```
RUN EQUATION-SOLVER
SELECT DATA-SET

SET
SET COMPANY-NAME
SET DISPLAY
SET DRAWING
SET GRAPH
SET PLOT
SET PRINT
SET TITLE
```

ASSIGN

ASSIGN	SPEED-REDUCTION-CURVE-WAVE-DIRECTION	...
	WAVE-DIRECTION-PROBABILITY	...
	WAVE-SPECTRUM-SHAPE	...
	WAVE-SPREADING-FUNCTION	...
	WAVE-STATISTICS	...

PURPOSE:

The assign command is used to assign wave spectra and wave energy spreading functions to wave statistics models, or to assign speed reduction data, probabilities and wave statistics models to existing wave directions.

ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION

...	SPEED-REDUCTION-CURVE-WAVE-DIRECTION	dir	name

PURPOSE:

To assign a speed-reduction curve to an existing wave direction for later use in calculating long term statistics and long term fatigue calculations. The assignment will override the previous assignment.

PARAMETERS:

dir   Wave direction

name   Name of speed-reduction curve

EXAMPLES:

```
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 180. SR1
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 210. SR1
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 240. SR1
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 270. SR1
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 300. SR1
ASSIGN SPEED-REDUCTION-CURVE-WAVE-DIRECTION 330. SR1
```

ASSIGN WAVE-DIRECTION-PROBABILITY

...	WAVE-DIRECTION-PROBABILITY	dir	prob

PURPOSE:

To assign a long term wave direction probability to an existing wave direction for later use in calculating long term statistics. The assignment will override the previous assignment.

PARAMETERS:

dir   Wave direction.

prob   Probability of the wave direction.

EXAMPLES:

```
ASSIGN WAVE-DIRECTION-PROBABILITY 180. 0.1666
ASSIGN WAVE-DIRECTION-PROBABILITY 210. 0.1666
ASSIGN WAVE-DIRECTION-PROBABILITY 240. 0.1666
ASSIGN WAVE-DIRECTION-PROBABILITY 270. 0.1666
ASSIGN WAVE-DIRECTION-PROBABILITY 300. 0.1666
ASSIGN WAVE-DIRECTION-PROBABILITY 330. 0.1666
```

ASSIGN WAVE-SPECTRUM-SHAPE

...	WAVE-SPECTRUM-SHAPE	name	PIERSON-MOSKOWITZ				...	ALL		
			JONSWAP	gam	sma	smb		PART	hsl	...
									hsu	...
			GENERAL-GAMMA	lsp	nsp				tzl	...
			ISSC						tzu	

PURPOSE:

To assign a wave spectrum shape to a wave scatter diagram. The assignment may be to the total scatter diagram, or to a selected part of the diagram. The assignments will override the previous assignments.

It is only possible to assign a wave spectrum shape to the total sea state area if the wave statistics is described through a Nordenstrøm model.

PARAMETERS:

name	Name of the wave statistics model.
PIERSON-MOSKOWITZ	Wave spectrum of type Pierson-Moskowitz (default)
JONSWAP	Wave spectrum of type JONSWAP
GENERAL-GAMMA	Wave spectrum of type general gamma
gam	Enhancement factor, γ, of JONSWAP spectrum.
sma	Left width, σa, of JONSWAP spectrum.
smb	Right width, σb, of JONSWAP spectrum.
lsp	l-parameter in the general gamma spectrum.
nsp	n-parameter in the general gamma spectrum.
ALL	Wave spectrum shape will be assigned to the total area of the wave statistics model.
PART	Wave spectrum shape will be assigned to an area of the scatter diagram limited by the square made of the parameters Hs_{lower}, Hs_{upper} and Ts_{lower}, Ts_{upper}.
hsl	Lower limit of the significant wave height, Hs.
hsu	Upper limit of the significant wave height, Hs.

tzl

Lower limit of the zero upcrossing wave period, Tz. Lower limit of the mean period T1 when ISSC spectrum

tzu

Upper limit of the zero upcrossing wave period, Tz. Upper limit of the mean period T1 when ISSC spectrum

NOTES:

If the command is not given, a Pierson-Moskowitz spectrum will be assumed.

EXAMPLES:

```
ASSIGN WAVE-SPECTRUM-SHAPE BMT GENERAL-GAMMA 5.0 4.0 ALL
ASSIGN WAVE-SPECTRUM-SHAPE DNV-NA JONSWAP 3.3 0.07 0.09 ALL
ASSIGN WAVE-SPECTRUM-SHAPE DNV-WW PIERSON-MOSKOWITZ ALL
ASSIGN WAVE-SPECTRUM-SHAPE ISSC1 ISSC ALL
```

ASSIGN WAVE-SPREADING-FUNCTION

...	WAVE-SPREADING-FUNCTION	name	sprnam	...	ALL				
			NONE		PART	hsl	hsu	tzl	tzu

PURPOSE:

To assign a wave energy spreading function to a wave statistics model. The assignment will override the previous assignment.

PARAMETERS:

name	Name of the wave statistics model.
sprnam	Name of the wave spreading function.
ALL	Wave spreading function will be assigned to the total area of the wave statistics model.
NONE	Long crested sea: no wave spreading function.
PART	Wave spreading function will be assigned to an area of the scatter diagram limited by the square made of Hs_{lower}, Hs_{upper} and Ts_{lower}, Ts_{upper}.
hsl	Lower limit of the significant wave height, Hs.
hsu	Upper limit of the significant wave height, Hs.
tzl	Lower limit of the zero upcrossing wave period, Tz.
tzu	Upper limit of the zero upcrossing wave period, Tz.

EXAMPLES:

```
ASSIGN WAVE-SPREADING-FUNCTION NRD USER1 ALL
ASSIGN WAVE-SPREADING-FUNCTION DNV-NA COS2 PART 1.0 5.0 2.0 6.0
```

ASSIGN WAVE-STATISTICS

...	WAVE-STATISTICS	dir	name

PURPOSE:

To assign a wave statistics model to a wave direction. The assignment will override the previous assignment.

PARAMETERS:

dir   Wave direction.

name   Name of the wave statistics model.

EXAMPLES:

```
ASSIGN WAVE-STATISTICS 180. DNV-NA
ASSIGN WAVE-STATISTICS 210. DNV-NA
ASSIGN WAVE-STATISTICS 240. DNV-NA
ASSIGN WAVE-STATISTICS 270. DNV-NA
ASSIGN WAVE-STATISTICS 300. DNV-NA
ASSIGN WAVE-STATISTICS 330. DNV-NA
```

CHANGE

	LONG-TERM-FATIGUE	...
	LONG-TERM-RESPONSE	...
	MATRIX	...
CHANGE	RESPONSE-VARIABLE	...
	SPECIFIC-POINT	...
	WAVE-SPECTRUM	...
	WAVE-SPREADING-FUNCTION	...
	WAVE-STATISTICS	...

PURPOSE:

This is used to change previously created responses and wave statistic tools.

The options and subcommands are mainly the same as for the corresponding CREATE command. The program will ask for the name of the object, and the default values of the different subcommands will be as given before.

CHANGE LONG-TERM-FATIGUE

...	LONG-TERM-FATIGUE	resp+	dir+	sn-curve

PURPOSE:

To change long term fatigue for a selected set of response variables and a set of global wave directions.

PARAMETERS:

resp   Name of the response variables for which the long term fatigue is to be calculated. Wild card specification is available.

dir   Main wave direction. Wild card specification is available.

sn-curve   Name of the SN-curve to be used.

EXAMPLES:

```
CHANGE LONG-TERM-FATIGUE ( ONLY STRESS ) ( ONLY 0.0 30. 60. 90.0 120.0 150. 180.0
210. 240.0 270.0 300.0 330. ) DNVC-II
```

CHANGE LONG-TERM-RESPONSE

... LONG-TERM-RESPONSE	RESPONSE-VARIABLE	resp+	dir+		
	SLAMMING	point	slprc	thrvel	dir+

PURPOSE:

To change long term responses given for either a selected set of response variables or in a slamming station (specified point).

PARAMETERS:

RESPONSE-VARIABLE	Long term response for a given response variable will be created.
SLAMMING	Long term slamming calculation is requested.
resp	Name of the response variables for which the long term response is to be calculated. Wild card specification is available.
dir	Main wave direction. Wild card specification is available.
point	Name of the specific point where long term slamming is calculated. The z-coordinate for this point must be given in the global coordinate systems, i.e. positive upwards, and will act as draft for the vessel at the given point.
slprc	Slamming pressure coefficient in given point.
thrvel	Threshold of relative velocity between wave and vessel. Slamming is defined to occur if the relative velocity exceeds this value when the vessel re-enters the water. The value is given as the Froude number: $\dfrac{v}{\sqrt{gL}}$
	v = velocity, g = gravity, L = characteristic length

EXAMPLES:

```
CHANGE LONG-TERM-RESPONSE RESPONSE-VARIABLE ( ONLY PITCH ROLL ) ( ONLY 0.0 22.5
45.0 67.5 90.0 135.0 180.0 )
CHANGE LONG-TERM-RESPONSE RESPONSE-VARIABLE ROLL 90.0

CHANGE LONG-TERM-RESPONSE SLAMMING FKPT1 1.0 0.15 90.0
CHANGE LONG-TERM-RESPONSE SLAMMING FKPT1 1.0 0.15 ( ONLY 0.0 22.5 45.0 67.5 90.0 )
```

CHANGE MATRIX

...	MATRIX	RESTORING	elem	val
		BODY-MATRIX		

PURPOSE:

To change the contents of a global matrix.

PARAMETERS:

RESTORING   Frequency independent hydrostatic restoring matrix.

BODY-MATRIX   Frequency independent inertia coefficient matrix.

elem   Element number in the matrix. The number must be specified as 2 digits separated
                     by a dot, giving the row and column number in a 6x6 matrix (e.g. 11 or 34).

val   Matrix value.

EXAMPLES:

```
CHANGE MATRIX RESTORING 33 5.11237e+006
CHANGE MATRIX BODY-MATRIX 11 2.41367e+007
```

CHANGE RESPONSE-VARIABLE

...	RESPONSE-VARIABLE	name	txt	dir	{freq, real, imag} *
		MIRROR	resp+		

PURPOSE:

To change the contents of a response variable.

PARAMETERS:

name   Name of the response variable.

txt   Descriptive text of the response variable.

dir   Global wave direction.

freq   Angular frequency.

real   Real part of the response variable.

imag   Imaginary part of the response variable.

MIRROR   Mirroring of selected response variables. The mirror plane is the XZ-plane. Modes in the mirror plane, such as Surge, Heave and Pitch, are symmetric. Modes normal to the mirror plane, such as Sway, Roll and Yaw, are anti symmetric. First order motions and excitation forces and sectional loads can be mirrored.

resp+   Selected names of response variables to be mirrored.

EXAMPLES:

```
CHANGE RESPONSE-VARIABLE STRESS 'STRESS' 90.0 INCLUDE .203 250.1 101.3
CHANGE RESPONSE-VARIABLE MIRROR HEAVE
```

CHANGE SN-CURVE

...	SN-CURVE	name	USER	txt	m0	s0	logN0	...

...	DEFAULT-TAIL				
	ALIGNED-WITH-FIRST				
	HORISONTAL-TAIL				
	ARBITRARY-TAIL	m1	ALIGNED-WITH-SECOND		
			HORISONTAL-TAIL	logN1	
			ARBITRARY-TAIL	logN1	m2

PURPOSE:

To change the properties of a SN-curve.

PARAMETERS:

name	Name of the SN-curve.
USER	Only user defined option available.
txt	Descriptive text of the SN-curve.
m0	Slope of first segment.
s0	Stress level at end first segment.
logN0	Log cycles to failure at end first segment.
DEFAULT-TAIL	Second segment continues with $m1 = 2*m0 - 1$.
ALIGNED-WITH-FIRST	Second segment continues with $m1 = m0$.
HORISONTAL-TAIL	Second segment is horizontal.
ARBITRARY-TAIL	Second segment is arbitrary.
m1	Slope of second segment.
ALIGNED-WITH-SECOND	Third segment continues with $m2 = m1$.
HORISONTAL-TAIL	Third segment is horizontal.
logN1	Log cycles to failure at end second segment.
m2	Slope of third segment.

EXAMPLES:

```
CHANGE SN-CURVE USE-X USER NONE 3.0 3.4 7.0 ARBITRARY-TAIL 5. HORISONTAL-TAIL 8.301
CHANGE SN-CURVE USE-Y USER NONE 3.0 3.4e+006 7.0 ALIGNED-WITH-FIRST
```

CHANGE SPECIFIC-POINT

...	SPECIFIC-POINT	name	txt	x-coor	y-coor	z-coor

PURPOSE:

To change the coordinates for a specific point.

PARAMETERS:

name   Name of the point.

txt   Descriptive text of the point.

x-coor   X-coordinate in the global coordinate system.

y-coor   Y-coordinate in the global coordinate system.

z-coor   Z-coordinate in the global coordinate system.

NOTE:

When using results from Wadam or Waveship the global coordinate system has the origin in the mean free surface.

EXAMPLE:

```
CHANGE SPECIFIC-POINT P1 MYPOINT 8.301 5.2 17.35
```

CHANGE WAVE-SPECTRUM

...	WAVE-SPECTRUM	name	txt	*several parameters*

PURPOSE:

To change an existing wave load spectrum.

PARAMETERS:

name	Name of the spectrum.
txt	Descriptive text for the spectrum.
several parameters	Wave spectrum parameters. These are dependent of the spectrum type previously given. See below.

GENERAL-GAMMA:

hs	Significant wave height, Hs.
tz	Zero upcrossing wave period, Tz.
lsp	l-parameter in the general gamma spectrum.
nsp	n-parameter in the general gamma spectrum.

JONSWAP:

hs	Significant wave height, Hs.
tz	Zero upcrossing period, Tz.
alpha	Slope parameter, α.
p-freq	Peak angular frequency, ω_p.
gamma	Enhancement factor, γ.
sigmaa	Left width, σ_a.
sigmab	Right width, σ_b.

OCHI-HUBBLE:

HsS	Significant wave height for the swell part.
TpS	Peak period for swell part.
GamS	Shape parameter for swell part.

HsW   Significant wave height for the wind part.

TpW   Peak period for wind part.

GamW   Shape parameter for wind part.

PIERSON-MOSKOWITZ:

hs   Significant wave height, Hs.

tz   Zero upcrossing wave period, Tz.

ISSC:

hs   Significant wave height, Hs.

t1   Mean wave period, T1.

USER-SPECIFIED:

freq   Input angular frequency.

dens   Specified energy density for input frequency.

EXAMPLES:

```
CHANGE WAVE-SPECTRUM OCHIHUB 'Ochi-Hubble spectrum' 2.0 20.0 1.5 6.0 10.0 3.0 0
```

CHANGE WAVE-SPREADING-FUNCTION

...	WAVE-SPREADING-FUNCTION	name	txt	COSINE-POWER	...
				USER-SPECIFIED	...

PURPOSE:

To change a wave energy spreading function.

CHANGE WAVE-SPREADING-FUNCTION COSINE-POWER

...	WAVE-SPREADING-FUNCTION	name	txt	COSINE-POWER	power

PURPOSE:

To change energy spreading for elementary wave directions by changing the power of a defined cosine function.

PARAMETERS:

name   Name of the spreading function.

txt   Descriptive text of the spreading function.

power   Power of the cosine function, given as an integer value.

EXAMPLES:

```
CHANGE WAVE-SPREADING-FUNCTION COS 'COSINE SPREADING' COSINE-POWER 3
```

CHANGE WAVE-SPREADING-FUNCTION USER-SPECIFIED

...	WAVE-SPREADING-FUNCTION	name	txt	USER-SPECIFIED	{dir, fact} *

PURPOSE:

To change energy spreading for elementary wave directions with user defined weights on each direction. The sum does not need to be equal to 1 since the program will normalize the weights when using the spreading function.

PARAMETERS:

name   Name of the spreading function.

txt   Descriptive text of the spreading function.

dir   Relative direction to the main wave direction in use. The range is, if spanning over 180 degrees, from -90 degrees to 90 degrees.

fact   Weight for each elementary wave direction relative to the main wave direction.

CHANGE WAVE-STATISTICS

...	WAVE-STATISTICS	name	txt	{tv, p(tv), h0, hc-h0, gamma}*				...
			ntz	distr	nsd	at	bt	...
			cond	nhs	hsmax	ah	bh	steep

PURPOSE:

To change wave statistics based on Nordenstrøm's theory. The program will verify whether the given name is used on a scatter diagram or a Nordenstrøm model.

PARAMETERS:

name	Name of the wave statistics.
txt	Descriptive text for the model.
tv	Visual wave period, Tv.
p(tv)	Probability that Tv falls within the interval represented by the class midpoint.
h0	Weibull parameter for the distribution function describing the probability that the visual wave height does not exceed Hv.
hc-h0	Weibull parameter.
gamma	Weibull parameter.
ntz	Number of zero upcrossing periods which will be used in the long term calculation.
distr	Distribution function of the zero upcrossing periods, Tz. Either NORMAL or LOG-NORMAL.
nsd	Number of standard deviations by which the range of Tz is extended at either end.
at	Parameter defining the relationship between zero upcrossing period, Tz, and visual wave period, Tv.
bt	Parameter defining the relationship between Tz and Tv.
cond	Conditional coefficient of variation of Tz.
nhs	Number of significant wave heights to be used in the calculation of the long term response.
hsmax	Maximum value of significant wave height. Minimum value used is 1.0 meter.
ah	Parameter defining the relationship between significant wave heights and visual wave heights.

bh   Parameter defining the relationship between Hs and Hv.

steep   Steepness criteria.

minq   Minimum probability level of which the value of x is requested for the long term distribution of x. The value is given as an absolute integer exponent, i.e. $Q(x) = 10^{-minq}$.

maxq   Maximum probability level of which the value of x is requested for the long term distribution of x.

incr   Step in absolute exponent.

CREATE

CREATE	LONG-TERM-FATIGUE	...
	LONG-TERM-RESPONSE	...
	RESPONSE-CO-SPECTRUM	...
	RESPONSE-SPECTRUM	...
	RESPONSE-VARIABLE	...
	SHORT-TERM-RESPONSE	...
	SPECIFIC-POINT	...
	SPEED-REDUCTION-CURVE	...
	WAVE-SPECTRUM	...
	WAVE-SPREADING-FUNCTION	...
	WAVE-STATISTICS	...
	WORKABILITY-ANALYSIS	...

PURPOSE:

The create command is the main command for creation of statistical data and the tools which may be used in the statistical operations. The user may, in the frequency domain, create different tools such as wave spectra, wave energy spreading functions or wave statistics models, and then select among these to calculate response spectra, short term responses, short term statistics or long term responses.

CREATE LONG-TERM-FATIGUE

...	LONG-TERM-FATIGUE	resp+	dir+	sn-curve

PURPOSE:

To create long term fatigue for a selected set of response variables and a set of global wave directions. The long term fatigue calculations will be based on a scatter diagram, using a Rayleigh distribution for each cell and a named SN-curve. Both the partial damage from each cell and total damage are calculated. The wave spectra and spreading functions used will be those assigned to the wave scatter diagram.

PARAMETERS:

resp   Name of the response variables for which the long term fatigue is to be calculated. Wild card specification is available.

dir   Main wave direction. Wild card specification is available.

sn-curve   Name of the SN-curve to be used.

EXAMPLES:

```
CREATE LONG-TERM-FATIGUE ( ONLY STRESS ) ( ONLY 0.0 30. 60. 90.0 120.0 150. 180.0
210.0 240.0 270.0 300.0 330. ) DNVC-I
```

CREATE LONG-TERM-RESPONSE

...	LONG-TERM-RESPONSE	RESPONSE-VARIABLE	resp+	dir+

PURPOSE:

To create long term responses for either a selected set of response variables or through slamming calculations for standard motions in a specified point, both for a selected set of global wave directions. The wave statistics model may be of type a Nordenstrøm model or a scatter diagram which is assigned to each wave direction selected. The wave spectra and spreading functions used will be those assigned to the wave statistics models.

PARAMETERS:

RESPONSE-VARIABLE   Long term response for a given response variable will be created.

resp   Name of the response variables for which the long term response is to be calculated. Wild card specification is available.

dir   Main wave direction. Wild card specification is available.

EXAMPLES:

```
CREATE LONG-TERM-RESPONSE RESPONSE-VARIABLE ( ONLY AG2 ) ( ONLY 0.0 15.0 30.0 45.0
60.0 75.0 90.0 )
```

CREATE RESPONSE-CO-SPECTRUM

...	RESPONSE-CO-SPECTRUM	resp1	resp2	dir+	spec+	sprea
						NONE

PURPOSE:

To create response cross spectra. For 2 response variables of the same kind, for each global wave direction and wave spectrum, a new response cross spectrum is created. The user may select several wave directions, wave spectra and one wave spreading function if short crested sea is assumed.

The program will generate internal numbers on each response cross spectrum, which will be used as reference later. The different numbers and a descriptive text for each response cross spectrum may be achieved by using the overview alternative under the PRINT RESPONSE-CO-SPECTRUM command.

PARAMETERS:

resp1	Name of the first response variable to be included in the co-spectrum calculation.
resp2	Name of the second response variable to be included in the co-spectrum calculation.
dir	Main wave direction. Wild card specification is available.
spec	Name of the wave spectrum to be used in the calculation. Wild card specification is available.
sprea	Name of the wave spreading function to be used in the calculation when short crested sea.
NONE	Long crested sea: no wave spreading function.

CREATE RESPONSE-SPECTRUM

...	RESPONSE-SPECTRUM	resp+	dir+	spec+	sprea
					NONE

PURPOSE:

To create response spectra, of type auto spectra. For each response variable, for each global wave direction and wave spectrum a new response spectrum is created. The user may select several response variables, several wave directions, wave spectra and one wave spreading function if short crested sea is assumed.

The program will generate internal numbers on each response spectrum, which will be used as reference later. The different numbers and a descriptive text for each response spectrum may be achieved by using the overview alternative under the PRINT RESPONSE-SPECTRUM command.

PARAMETERS:

resp   Name of the response variable for which the response spectrum is to be calculated. Wild card specification is available.

dir   Main wave direction. Wild card specification is available.

spec   Name of the wave spectrum to be used in the calculation. Wild card specification is available.

sprea   Name of the wave spreading function to be used in the calculation when short crested sea.

NONE   Long crested sea: no wave spreading function.

EXAMPLES:

```
CREATE RESPONSE-SPECTRUM ( ONLY HEAVE ) ( ONLY 90.0 ) ( ONLY PMSINGLE ) NONE
```

CREATE RESPONSE-VARIABLE

...	RESPONSE-VARIABLE	name	text	COMBINED-MOTION	...
				FIRST-DERIVATED	...
				GENERAL-COMBINATION	...
				SECOND-DERIVATED	...
				USER-SPECIFIED	...

PURPOSE:

To create internal response variables, either as combinations of existing response variables, or as sole user specified response variables.

CREATE RESPONSE-VARIABLE COMBINED-MOTION

...	RESPONSE-VARIABLE	name	txt	COMBINED-MOTION	point	...

...	resp+	DISPLACEMENT	...	RELATIVE	mode
		VELOCITY		ABSOLUTE	
		ACCELERATION			

PURPOSE:

To create a combination of global motion responses. The combination will be a standard motion combination of a given point consisting of either displacement, velocity or acceleration, absolute or relative to sea surface elevation.

PARAMETERS:

name	Name of the response variable.
txt	Descriptive text of the response variable.
point	Point of which the combination is to be defined.
resp	Name of the global motion response variable to be included in the combination. Wild card specification is available.
DISPLACEMENT	Response variable for combined displacement of the point will be generated.
VELOCITY	Response variable for combined velocity of the point will be generated.
ACCELERATION	Response variable for combined acceleration of the point will be generated.
RELATIVE	Relative motion compared to sea surface elevation in vertical direction below or above the given specific point.
ABSOLUTE	Absolute motion will be generated.
mode	The degree of freedom of the generated response variable. Relative motion only in z-direction.

EXAMPLES:

```
CREATE RESPONSE-VARIABLE AG1 'Air gap' COMBINED-MOTION PF ( ONLY HEAVE PITCH ROLL
SURGE SWAY YAW ) DISPLACEMENT RELATIVE Z
```

CREATE RESPONSE-VARIABLE FIRST-DERIVATED

...	RESPONSE-VARIABLE	name	txt	FIRST-DERIVATED	resp

PURPOSE:

To create a the first derivative of a selected response variable. The response variable will be created by multiplying each amplitude by its angular frequency, i.e. the real and imaginary part is multiplied by $i\omega$.

PARAMETERS:

name   Name of the response variable.

txt   Descriptive text of the response variable.

resp   Name of the response variable to be included in the combination.

CREATE RESPONSE-VARIABLE GENERAL-COMBINATION

...	RESPONSE-VARIABLE	name	txt	GENERAL-COMBINATION	{resp, fact}*

PURPOSE:

The main purpose is to create combinations of sectional force response variables. However, the command may be used to combined any response variables where each component is added together with a scaling factor.

PARAMETERS:

name   Name of the response variable.

txt   Descriptive text of the response variable.

resp   Name of the response variable.

fact   Multiplication factor for the corresponding response variable. All selected response variables will then be added together.

EXAMPLES:

```
CREATE RESPONSE-VARIABLE AG2 'Air gap' GENERAL-COMBINATION ( ONLY MOT1 1.0 elev2
-1.0 )
```

CREATE RESPONSE-VARIABLE SECOND-DERIVATED

...	RESPONSE-VARIABLE	name	txt	SECOND-DERIVATED	resp

PURPOSE:

To create a the second derivative of a selected response variable. The response variable will be created by multiplying each amplitude by its squared angular frequency, i.e. the real and imaginary part is multiplied by $-\omega^2$.

PARAMETERS:

name   Name of the response variable.

txt   Descriptive text of the response variable.

resp   Name of the response variable.

CREATE RESPONSE-VARIABLE USER-SPECIFIED

...	RESPONSE-VARIABLE	name	txt	USER-SPECIFIED	...

...	depth	{dir, freq, real, imag} *	
	SPEED-INCLUDED	depth	{froude, dir, freq, real, imag} *

PURPOSE:

The command is used for direct input of new transfer functions. Maximum number of frequencies is 200 and they may be given in random order. The forward speed may be given as a Froude number and will be taken into account in calculation of the statistical moments.

PARAMETERS:

name   Name of the response variable.

txt   Descriptive text of the response variable.

depth   Water depth.

dir   Wave direction (0-360 degrees).

freq   Angular frequency.

real   Real part of the transfer function value.

imag   Imaginary part of the transfer function value.

froude   Froude number.

EXAMPLES:

```
CREATE RESPONSE-VARIABLE STRESS 'STRESS' USER-SPECIFIED 1000 ( ONLY

      0           0.161             6.13E+05            2.90E+04

      0           0.175             5.64E+05            3.29E+04

      0           0.19              4.32E+05            3.42E+04

      ...... )
```

CREATE SHORT-TERM-RESPONSE

...	SHORT-TERM-RESPONSE	resp+	dir+	prfx	mins	maxs	sprea
							NONE

PURPOSE:

To create short term response for a set of Tz-values. The wave spectra to be used ***have to be generated by the FULL-RANGE alternative.*** These spectra are named as a combination of the user given prefix and a sequence number, i.e. prfx1, prfx2, prfx3 etc. If the user wishes to know what sequence numbers available, this might be done by use of the PRINT OVERVIEW WAVE-SPECTRUM command. The value calculated for each zero upcrossing period, Tz, is significant response pr. Hs, i.e. four times the square root of the zero-moment.

PARAMETERS:

resp   Name of the response variable for which the short term response is to be calculated. Wild card specification is available.

dir   Main wave direction. Wild card specification is available.

prfx   Prefix of the full range wave spectra to be used.

mins   Minimum sequence number of the full-range wave spectra to be used.

maxs   Maximum sequence number of the full-range wave spectra to be used.

sprea   Name of the wave spreading function to be used in the calculation when short crested sea.

NONE   Long crested sea: no wave spreading function.

EXAMPLES:

```
CREATE SHORT-TERM-RESPONSE ( ONLY AG2 SUB2 FY ) ( ONLY 90.0 ) PM 1 21 NONE
```

CREATE SN-CURVE

...	SN-CURVE	name	USER	txt	m0	s0	logN0	...

...	DEFAULT-TAIL			
	ALIGNED-WITH-FIRST			
	HORISONTAL-TAIL			
	ARBITRARY-TAIL	m1	ALIGNED-WITH-SECOND	
			HORISONTAL-TAIL	logN1	
			ARBITRARY-TAIL	logN1	m2

PURPOSE:

To create an SN-curve with up to 3 segments.

PARAMETERS:

name	Name of the SN-curve.
USER	Only user defined option available.
txt	Descriptive text of the SN-curve.
m0	Slope of first segment.
m0	Stress level at end first segment.
logN0	Log cycles to failure at end first segment.
DEFAULT-TAIL	Second segment continues with $m1 = 2*m0 - 1$.
ALIGNED-WITH-FIRST	Second segment continues with $m1 = m0$.
HORISONTAL-TAIL	Second segment is horizontal.
ARBITRARY-TAIL	Second segment is arbitrary.
m1	Slope of second segment.
ALIGNED-WITH-SECOND	Third segment continues with $m2 = m1$.
HORISONTAL-TAIL	Third segment is horizontal.
logN1	Log cycles to failure at end second segment.
m2	Slope of third segment.

CREATE SPECIFIC-POINT

| ... | SPECIFIC-POINT | name | txt | x-coor | y-coor | z-coor |

PURPOSE:

To create specific points of which the user can generate absolute or relative displacement, velocity or acceleration combinations.

PARAMETERS:

name   User given name of the point.

txt   Descriptive text of the point.

x-coor   X-coordinate in the global coordinate system.

y-coor   Y-coordinate in the global coordinate system.

z-coor   Z-coordinate in the global coordinate system (origin in the free surface).

EXAMPLES:

```
CREATE SPECIFIC-POINT PF 'Point for air gap computation' 27. 0. 12.5
```

CREATE SPEED-REDUCTION-CURVE

...	SPEED-REDUCTION-CURVE	name	txt	{Hs, Froude}*

PURPOSE:

A speed-reduction curve gives what Froude number (speed) to use in a given sea-state as a function of significant wave-height. This is used when the contribution from each cell (sea-state) in a scatter diagram is calculated in a long-term calculation. If the Froude-number prescribed by the speed-reduction curve does not exist in the result data input to POSTRESP, data for this Froude-number is interpolated among the given ones.

PARAMETERS:

name   User given name of the speed-reduction curve.

txt   Descriptive text of the speed-reduction curve.

Hs   Significant wave height.

Froude   Froude number.

EXAMPLES:

```
CREATE SPEED-REDUCTION-CURVE SR2 SPEED-RED ( INCLUDE 5.0 0.2 6.0 0.18 8.0 0.16 )
```

CREATE WAVE-SPECTRUM

...	WAVE-SPECTRUM	name	txt	2D-USER-SPECIFIED	...
				GENERAL-GAMMA	...
				ISSC	...
				JONSWAP	...
				OCHI-HUBBLE	...
				PIERSON-MOSKOWITZ	...
				TORSETHAUGEN	...
				USER-SPECIFIED	...

PURPOSE:

To create wave load spectra. The wave load spectra is typically used for generation of response spectra or short term responses.

CREATE WAVE-SPECTRUM 2D-USER-SPECIFIED

...	WAVE-SPECTRUM	name	txt	2D-USER-SPECIFIED	{wdir, freq, dens}*

PURPOSE:

To create a general user specified directional wave spectrum where the user may give the energy density for selected wave directions and frequencies.

PARAMETERS:

name   Name of the spectrum.

txt   Descriptive text of the spectrum.

wdir   Input wave direction.

freq   Input angular frequency.

dens   Specified energy density for input frequency.

EXAMPLES:

```
CREATE WAVE-SPECTRUM User2d ' ' 2D-USER-SPECIFIED

( ONLY

    0   .1   1

    0  1.0   2

   45   .1   3

   45   .1   4

            )
```

CREATE WAVE-SPECTRUM GENERAL-GAMMA

...	WAVE-SPECTRUM	name	txt	GENERAL-GAMMA			...

	FULL-RANGE	tzmin	tzmax	incr	lsp	nsp
...	SCATTER-DIAGRAM	lsp	nsp			
	SINGLE	hs	tz	lsp	nsp	

PURPOSE:

To create a single or full range set of wave spectra based on a general gamma spectrum type. If the option FULL-RANGE is used, the first 4 letters of the name will be used as prefix for the automatic name generation.

Note that a general gamma spectrum cannot be displayed or plotted.

PARAMETERS:

name	Name of the spectrum or prefix of the full-range generated spectra.
txt	Descriptive text of the spectrum. If FULL-RANGE, the 20 first letters will be used in addition to the internal text generation, e.g. 'Tz = 10.0'.
FULL-RANGE	Full range calculation of general gamma spectra. I.e. wave spectra with Hs equal to 1.0 and different Tz-values given as a range will be generated. This alternative will create internal names, which will be prfx****, where prfx is the first 4 letters of the name given and **** is an integer number in increasing order (see Section 3.3.
lsp	l-parameter in the general gamma spectrum.
nsp	n-parameter in the general gamma spectrum.
tzmin	Minimum value of Tz for full range calculation.
tzmax	Maximum value of Tz for full range calculation.
incr	Increment between *tzmin* and *tzmax*. Total number of generated spectra will be (maximum-minimum)/increment + 1.
SCATTER-DIAGRAM	A set of wave spectra are generated based on the Tz values, with Hs values equal to 1, for the wave scatter diagram assigned to the corresponding wave spectrum shape.
SINGLE	A single wave spectrum is generated.
hs	Significant wave height, Hs.
tz	Zero upcrossing wave period, Tz.

CREATE WAVE-SPECTRUM ISSC

...	WAVE-SPECTRUM	name	txt	ISSC	...

...	FULL-RANGE	t1-min	t1-max	incr
	ISSC-SCATTER-DIAGRAM			
	SINGLE	hs	t1	

PURPOSE:

To create wave spectra based on a ISSC spectrum type.

PARAMETERS:

name	Name of the spectrum.
txt	Descriptive text of the spectrum. If FULL-RANGE, the 20 first letters will be used in addition to the internal text generation, e.g. 'T1 = 10.0'.
FULL-RANGE	Full range calculation of ISSC spectra. I.e. wave spectra with Hs equal to 1.0 and different T1-values given as a range will be generated. This alternative will create internal names, which will be prfx****, where prfx is the first 4 letters of the name given and **** is an integer number in increasing order (see Section 3.3).
t1min	Minimum value of T1 for full range calculation.
t1max	Maximum value of T1 for full range calculation.
incr	Increment between tzmin and tzmax. Total number of generated spectra will be (maximum-minimum)/increment + 1.
SCATTER-DIAGRAM	A set of wave spectra are generated based on the T1 values, with Hs values equal to 1, for the wave scatter diagram assigned to the corresponding wave spectrum shape.
SINGLE	A single wave spectrum is generated.
hs	Significant wave height, Hs.
t1	Mean wave period, T1.

EXAMPLES:

```
CREATE WAVE-SPECTRUM ISSCSNGL 'Hs=8m, T1=0s' ISSC SINGLE 8 10
CREATE WAVE-SPECTRUM ISSCFULL 'T1=10 to T1=20' ISSC FULL-RANGE 10 20 0.5
```

CREATE WAVE-SPECTRUM JONSWAP

...	WAVE-SPECTRUM	name	txt	JONSWAP	...

...	FULL-RANGE	HS- TZ		tzmin	tzmax	...
				incr		...
				gamma	sigmaa	...
				sigmab		
		ALPHA-OMEGAP		p-frmin	p-frmax	...
				incr	gamma	...
				sigmaa	sigmab	...
	SCATTER-DIAGRAM	gamma		sigmaa	sigmab	
	SINGLE	HS-TZ	hs	tz	gamma	...
				sigmaa	sigmab	
		ALPHA-OMEGAP		alpha	p-freq	...
				gamma	sigmaa	...
					sigmab	

PURPOSE:

To create wave spectra based on a JONSWAP spectrum type.

PARAMETERS:

name	Name of the spectrum.
txt	Descriptive text of the spectrum. If FULL-RANGE, the 20 first letters will be used in addition to the internal text generation, e.g 'Tz = 10.0'.
FULL-RANGE	Full range calculation of JONSWAP spectra. I.e. wave spectra with Hs equal to 1.0 and different Tz-values given as a range will be generated. This alternative will create internal names, which will be prfx****, where prfx is the first 4 letters of the name given and **** is an integer number in increasing order (see Section 3.3).
HS-TZ	The calculation of the spectrum will be based on a significant wave height, Hs and zero upcrossing period, Tz. (Hs = 1 for Full Range calculation.)
hs	Significant wave height, Hs.
tz	Zero upcrossing wave period, Tz.
ALPHA-OMEGAP	The calculation of the spectrum will be based on the wave spectrum parameters ω_p.

alpha	Slope parameter, α, of JONSWAP spectrum.
p-frmin	Minimum value of the peak angular frequency, ω_p for full range calculation.
p-frmax	Maximum value of the peak angular frequency, ω_p for full range calculation.
p-freq	Peak angular frequency, ω_p, of JONSWAP spectrum.
gamma	Enhancement factor, γ, of JONSWAP spectrum. Default is 3.3.
sigmaa	Left width, σ_a, of JONSWAP spectrum. Default is 0.07.
sigmab	Right width, σ_b, of JONSWAP spectrum. Default is 0.09.
tzmin	Minimum value of Tz when full range calculation.
tzmax	Maximum value of Tz when full range calculation.
incr	Increment between *tzmin* and *tzmax*. Total number of generated spectra will be (maximum-minimum)/increment + 1.
SCATTER-DIAGRAM	A set of wave spectra are generated based on the Tz values, with Hs values equal to 1, for the wave scatter diagram assigned to the corresponding wave spectrum shape.
SINGLE	A single wave spectrum is generated.

CREATE WAVE-SPECTRUM OCHI-HUBBLE

| ... | WAVE-SPECTRUM | name | txt | OCHI-HUBBLE | SINGLE | ... |

| ... | HsS | TpS | GamS | HsW | TpW | GamW |

PURPOSE:

To create wave spectra based on a Ochi-Hubble spectrum type.

The Ochi-Hubble wave spectrum is a two-peak spectrum divided in two parts, each reminiscent of the General Gamma spectrum, modelling one contribution from swell and one for wind-generated sea.

PARAMETERS:

name   Name of the spectrum.

txt   Descriptive text of the spectrum.

HsS   Significant wave height for the swell part.

TpS   Peak period for swell part.

GamS   Shape parameter for swell part.

HsW   Significant wave height for the wind part.

TpW   Peak period for wind part.

GamW   Shape parameter for wind part.

NOTES:

The application of this spectrum is restricted to creating response spectrum and computation of short term statistics (along with print and display of the spectrum). Long term statistical processing involving this spectrum is not offered in Postresp. Fatigue calculations based on this spectrum can be done in Framework. The main purpose in Postresp in this case is to supply Framework with some display and print functionality.

EXAMPLES:

```
CREATE WAVE-SPECTRUM OCHIHUB 'Ochi-Hubble spectrum' OCHI-HUBBLE SINGLE 2 20 1.5 6
10 3 OCHI-HUBBLE
```

CREATE WAVE-SPECTRUM PIERSON-MOSKOWITZ

...	WAVE-SPECTRUM	name	txt	PIERSON-MOSKOWITZ		...

	FULL-RANGE	tz-min	tz-max	incr
...	SCATTER-DIAGRAM			
	SINGLE	hs	tz	

PURPOSE:

To create wave spectra based on a Pierson-Moskowitz spectrum type.

PARAMETERS:

name	Name of the spectrum.
txt	Descriptive text of the spectrum. If FULL-RANGE, the 20 first letters will be used in addition to the internal text generation, e.g. 'Tz = 10.0'.
FULL-RANGE	Full range calculation of PIERSON-MOSKOWITZ spectra. I.e. wave spectra with Hs equal to 1.0 and different Tz-values given as a range will be generated. This alternative will create internal names, which will be prfx****, where prfx is the first 4 letters of the name given and **** is an integer number in increasing order (see Section 3.3).
tzmin	Minimum value of Tz for full range calculation.
tzmax	Maximum value of Tz for full range calculation.
incr	Increment between tzmin and tzmax. Total number of generated spectra will be (maximum-minimum)/increment + 1.
SCATTER-DIAGRAM	A set of wave spectra are generated based on the Tz values, with Hs values equal to 1, for the wave scatter diagram assigned to the corresponding wave spectrum shape.
SINGLE	A single wave spectrum is generated.
hs	Significant wave height, Hs.
tz	Zero upcrossing wave period, Tz.

EXAMPLES:

```
CREATE WAVE-SPECTRUM PMSINGLE 'Hs=8m, Tz=10s' PIERSON-MOSKOWITZ SINGLE 8 10
CREATE WAVE-SPECTRUM PM 'Tz=10 to Tz=20' PIERSON-MOSKOWITZ FULL-RANGE 10 20 0.5
```

CREATE WAVE-SPECTRUM TORSETHAUGEN

...	WAVE-SPECTRUM	name	txt	TORSETHAUGEN	...

	FULL-RANGE	tp-min	tp-max	incr
...	SINGLE	hs	tp	

PURPOSE:

To create wave spectra based on a Torsethaugen spectrum type.

The Torsethaugen spectrum is a two-peak wave spectrum which can be applied for short term statistics. The spectrum can also be printed and displayed.

PARAMETERS:

name   Name of the spectrum.

txt   Descriptive text of the spectrum.

FULL-RANGE   Full range calculation of TORSETHAUGEN spectra. I.e. wave spectra with Hs equal to 1.0 and different Tp-values given as a range will be generated. This alternative will create internal names, which will be prfx****, where prfx is the first 4 letters of the name given and **** is an integer number in increasing order (see Section 3.3).

tp-min   Minimum value of Tp for full range calculation.

tp-max   Maximum value of Tp for full range calculation.

incr   Increment between tpmin and tpmax. Total number of generated spectra will be (maximum-minimum)/increment + 1.

SINGLE   A single wave spectrum is generated.

hs   Significant wave height, Hs.

tp   Peak period, Tp.

NOTES:

This spectrum is not included in the long-term statistics.

The parameter is Tp (peak period) and not Tz (Zero-upcrossing period).

CREATE WAVE-SPECTRUM USER-SPECIFIED

...	WAVE-SPECTRUM	name	txt	USER-SPECIFIED	{freq, dens}*

PURPOSE:

To create a user specified spectrum where the user may give the energy density for selected frequencies. These frequencies does not have to correspond to the frequencies given for the response variables. For use in the statistical calculations, note that the area of angular frequencies has to be the same area as given for the response variable it shall be combined with. Maximum number of frequencies is 201 and they may be given in random order.

PARAMETERS:

name   Name of the spectrum.

txt   Descriptive text of the spectrum.

freq   Input angular frequency.

dens   Specified energy density for input frequency.

EXAMPLES:

```
CREATE WAVE-SPECTRUM TESTSPEC ' ' USER-SPECIFIED ( 0.1 1. 0.2 1. 0.3 1. 0.4 1. 0.5
1. 0.6 1. 0.7 1. 0.8 1. 0.9 1. 1.0 1. )
```

CREATE WAVE-SPREADING-FUNCTION

...	WAVE-SPREADING-FUNCTION	name	txt	COSINE-POWER	...
				USER-SPECIFIED	...

PURPOSE:

To create wave energy spreading for elementary wave directions.

CREATE WAVE-SPREADING-FUNCTION COSINE-POWER

...	WAVE-SPREADING-FUNCTION	name	txt	COSINE-POWER	power

PURPOSE:

To create energy spreading for elementary wave directions by a cosine of power n.

PARAMETERS:

name   Name of the spreading function.

txt   Descriptive text of the spreading function.

power   Power of the cosine function, given as an integer value. Default is 2.

EXAMPLES:

```
CREATE WAVE-SPREADING-FUNCTION COS2 'Cosine squared' COSINE-POWER 2
```

CREATE WAVE-SPREADING-FUNCTION USER-SPECIFIED

...	WAVE-SPREADING-FUNCTION	name	txt	USER-SPECIFIED	{dir, fact}*

PURPOSE:

To create energy spreading for elementary wave directions with user defined weights on each direction. The sum does not need to be equal to 1 since the program will normalize the weights when using the spreading function.

PARAMETERS:

name   Name of the spreading function.

txt   Descriptive text of the spreading function.

dir   Relative direction to the main wave direction in use. The range is, if spanning over 180 degrees, from -90 degrees to 90 degrees.

fact   Weight for each elementary wave direction relative to the main wave direction.

CREATE WAVE-STATISTICS

...	WAVE-STATISTICS	name	ISSC-SCATTER-DIAGRAM
			NORDENSTROM
			SCATTER-DIAGRAM

PURPOSE:

To create long term description of different sea states.

CREATE WAVE-STATISTICS ISSC-SCATTER-DIAGRAM

...	WAVE-STATISTICS	name	txt	ISSC-SCATTER-DIAGRAM	...

...	PROBABILITY	{hs, t1, prob} *
	OCCURENCE	{hs, t1, occ} *

PURPOSE:

To create wave statistics model for use in the long term response calculation. The current wave statistics model describes the sea state conditions during a long term period and consists of T1 and Hs values and their probability of occurrence. By this command, the wave statistics model is given through a ISSC scatter diagram.

PARAMETERS:

name	Name of the wave statistics.
txt	Descriptive text for the model.
PROBABILITY	Each sea state, i.e. cell in the diagram will be given a probability of occurrence.
OCCURENCE	Each sea state, i.e. cell in the diagram will be given as number occurrences during the long term period.
hs	Significant wave height, Hs.
t1	Mean period, T1.
prob	Probability for given zero upcrossing period, T1 and significant wave height, Hs.
occ	Occurrence of the seastate given the zero upcrossing period, T1 and significant wave height, Hs.

EXAMPLES:

```
CREATE WAVE-STATISTICS WISSC 'ISSC Scatter diagram for SESAM field'
                       ISSC-SCATTER-DIAGRAM PROBABILITY
                   ( 5.0   6.0   0.1
                     6.0   6.0   0.3
                     7.0   6.5   0.5
                     8.0   5.5   0.1 )
```

CREATE WAVE-STATISTICS NORDENSTROM

...	WAVE-STATISTICS	name	txt	NORDENSTROM	{tv, p(tv), h0, hc-h0, gamma} *			...
					ntz	distr	nsd	...
					at	bt	cond	...
					nhs	hsmax	ah	...
					bh	steep		

PURPOSE:

To create wave statistics models for use in the long term response calculation. The wave statistics model describes the sea state conditions during a long term period, and consists of mainly Tz and Hs values and their probability of occurrence. By this command, the wave statistics model will be according to Nordenstrøm's theory.

PARAMETERS:

name   Name of the wave statistics.

txt   Descriptive text for the model.

tv   Visual wave period, Tv.

p(tv)   Probability that Tv falls within the interval represented by the class midpoint.

h0   Weibull parameter for the distribution function describing the probability that the visual wave height does not exceed Hv.

hc-h0   Weibull parameter.

gamma   Weibull parameter.

ntz   Number of zero upcrossing periods which will be used in the long term calculation.

distr   Distribution function of the zero upcrossing periods, Tz. Either NORMAL or LOG-NOR-MAL.

nsd   Number of standard deviations by which the range of Tz is extended at either end.

at   Parameter defining the relationship between zero upcrossing period, Tz, and visual wave period, Tv.

bt   Parameter defining the relationship between Tz and Tv.

cond   Conditional coefficient of variation of Tz.

nhs   Number of significant wave heights to be used in the calculation of the long term response.

hsmax   Maximum value of significant wave height. Minimum value used is 1.0 meter.

ah   Parameter defining the relationship between significant wave heights and visual wave heights.

bh   Parameter defining the relationship between Hs and Hv.

steep   Steepness criteria.

CREATE WAVE-STATISTICS SCATTER-DIAGRAM

...	WAVE-STATISTICS	name	txt	SCATTER-DIAGRAM	...

...	PROBABILITY	{hs, tz, prob} *
	OCCURENCE	{hs, tz, occ} *

PURPOSE:

To create wave statistics model for use in the long term response calculation. The wave statistics model describes the sea state conditions during a long term period and consists of mainly Tz and Hs values and their probability of occurrence. By this command, the wave statistics model is given through a scatter diagram.

PARAMETERS:

name	Name of the wave statistics.
txt	Descriptive text for the model.
PROBABILITY	Each sea state, i.e. cell in the diagram will be given a probability of occurrence.
OCCURENCE	Each sea state, i.e. cell in the diagram will be given as number occurrences during the long term period.
hs	Significant wave height, Hs.
tz	Zero upcrossing period, Tz.
prob	Probability for given zero upcrossing period, Tz and significant wave height, Hs.
occ	Occurrence of the seastate given the zero upcrossing period, Tz and significant wave height, Hs.

EXAMPLES:

```
CREATE WAVE-STATISTICS WS3 'Scatter diagram for SESAM field'
                        SCATTER-DIAGRAM PROBABILITY
                        ( 5.0   6.0  0.1
                          6.0   6.0  0.3
                          7.0   6.5  0.5
                          8.0   5.5  0.1 )
```

CREATE WORKABILITY-ANALYSIS

...	WORKABILITY-ANALYSIS	name	txt	{resp, rmsall} *	dir+

PURPOSE:

To create a workability analysis for a set of response variables and selected wave directions. For each wave direction used, a scatter diagram must be assigned. The allowable response level (double amplitude) specified for each response variable is compared with the significant response calculated in each cell of the scatter diagram. If the significant response is less than the allowable level, the probability or number of occurrences for this cell is added to a total sum.

The total contribution of this is a measurement of the up time period for the vessel in the given long term condition.

PARAMETERS:

name   Name of the workability analysis.

txt   Descriptive text for the analysis.

resp   Name of the response variable included.

rmsall   Allowable response level (double amplitude).

dir   Main wave direction. Wild card specification is available.

DEFINE

DEFINE	CONSTANT	...
	FREQUENCY-RANGE	...
	LONG-TERM-PROBABILITY	...
	PRESENTATION-OPTION	...
	RETURN-PERIOD	...
	SPEED-REDUCTION	...
	STRUCTURE-ORIENTATION	...

PURPOSE:

The define command is used to define different global variables and execution directives.

DEFINE CONSTANT

...	CONSTANT	GRAVITY	grav
		WATER-DENSITY	rho
		HS-TOLERANCE	HsTol
		TZ-TOLERANCE	TzTol
		FREQUENCY-TOLERANCE	FrqTol

PURPOSE:

To define global constants for use in the program.

PARAMETERS:

grav   Gravity, default = 9.81 m/s^2.

rho   Water density, default = 1025 kg/m^3.

HsTol   Numerical tolerance between different Hs-values.

TzTol   Numerical tolerance between different Tz-values.

FrqTol   Numerical tolerance between different angular frequencies.

DEFINE FREQUENCY-RANGE

...	FREQUENCY-RANGE	low-freq	upp-freq

PURPOSE:

To define the frequency range within which the wave spectra will be established. By default, the range will be as given on the Results Interface File read in. If no Interface file is used, this has to be specified by the user.

PARAMETERS:

low-freq   Lower angular frequency.

upp-freq   Upper angular frequency.

DEFINE LONG-TERM-PROBABILITY

...	LONG-TERM-PROBABILITY	log-Q*

PURPOSE:

To define long term probability level for which the value of x is requested for the long term distribution of x.

PARAMETERS:

log-Q   The probability given as an absolute integer exponent, i.e. $Q(x) = 10\text{-log}(-Q)$.

DEFINE PRESENTATION-OPTION

...	PRESENTATION-OPTION	SIMULTANEOUS-BODIES	SINGLE
			ALL
		ABSCISSA-AXIS	ANGULAR-FREQUENCY
			ENCOUNTER-FREQUENCY
			PERIOD
			WAVE-LENGTH
		RESPONSE-VARIABLE	...

...	CONTOUR-LEVELS	Low		High	Step	
	ORDINATE-UNITS	DEGREES				
		RADIANS				
	ORDINATE-VALUES	AMPLITUDE				
		PHASE-AMPLITUDE				
		REAL-IMAGINARY				
	SECOND-ORDER-GRAPH	FIRST-DIRECTION				
		SECOND-DIRECTION				
		SUM			FIRST-DIRECTION	
					SECOND-DIRECTION	
					DIFFERENCE	
		DIFFERENCE			FIRST-DIRECTION	
					SECOND-DIRECTION	
					SUM	

PURPOSE:

To define presentation options for the graphic or print presentation.

PARAMETERS:

SIMULTANEOUS-BODIES   Switch between access to a SINGLE body (the currently select-
                                   ed body) or ALL available bodies in the same graph. Selecting
                                   ALL will generate a prompt for body selection in the **DIS-
                                   PLAY** command.

ABSCISSA-AXIS   Switch between ANGULAR-FREQUENCY, wave PERIOD
                                   WAVE-LENGTH, ENCOUNTER-FREQUENCY on the ab-

scissa axis when displaying response variables and wave spectra. This will also influence the print of response variables, such that the first column written in the table will be according to chosen abscissa axis.

RESPONSE-VARIABLE	All items under this branch of the command applies to presentation of response variables only.
CONTOUR-LEVELS	Contour levels to be used for display of a second order response variable as a contour graph. The contour levels are given as an equidistant set of values, by specifying the lowest value, the highest value and a step value. The values will be of the form Low + i*Step, starting from \<Low\> and not exceeding \<High\>.
ORDINATE-VALUES	Switch between real and imaginary or amplitude display of first order response variables. This option has no effect on presentation of second order response variables.
AMPLITUDE	One or several response variable amplitudes are displayed.
PHASE-AMPLITUDE	One response variable with amplitude and phase angles is displayed.
REAL-IMAGINARY	The real and imaginary part of one response variable is displayed in the same graph.
ORDINATE-UNITS	Switch between degrees or radians (default) as angular units when presenting rotational modes.
DEGREES	The rotational modes will be presented in print and plots in degrees.
RADIANS	The rotational modes will be presented in print and plots in radians.
SECOND-ORDER-GRAPH	This option determines how a graph is displayed as a cut in the functional presentation of a second order response variable. The second order response variable is, for each given set of directions, a function of two frequencies.

The first choice determines the cut to be shown, by selecting what is to be fixed (the fixed value itself is entered into the **DISPLAY** command).

The possibilities are:

FIRST-DIRECTION	Fix a frequency value in the first direction.
SECOND-DIRECTION	Fix a frequency value in the second direction.
SUM	Fix the sum of the frequencies
DIFFERENCE	Fix the difference of the frequencies.

The second choice determines the value to place on the abscissa axis. This is a function of the choice of cut in the function.

When a first or second direction value is fixed, the abscissa will be the other direction (second or first).

When the sum of the frequencies is fixed, the abscissa can be either the FIRST-DIRECTION, the SECOND-DIRECTION or the DIFFERENCE.

When the difference of the frequencies is fixed, the abscissa can be either the FIRST-DIRECTION, the SECOND-DIRECTION or the SUM.

DEFINE RETURN-PERIOD

...	RETURN-PERIOD	period*

PURPOSE:

To define return periods used in the long term response calculations.

PARAMETERS:

period   Return period (in years).

DEFINE SPEED-REDUCTION

...	SPEED-REDUCTION	ON/OFF

PURPOSE:

This is used to specify that speed-reduction will be taken into account in long-term statistics and long-term fatigue calculations. When speed-reduction is ON, the Froude-number choice will be absent in the DIS-PLAY LONG-TERM-RESPONSE command, since the results then do not relate to any given Froude number.

PARAMETERS:

ON/OFF   Switch speed-reduction on or off (off is default).

DEFINE STRUCTURE-ORIENTATION

...	STRUCTURE-ORIENTATION	angle

PURPOSE:

To define the global orientation of the structure. The orientation will be used when reading in external scatter diagrams from a file.

PARAMETERS:

angle   Angle relative to global X-axis (in degrees). The angle is given positive anti clockwise.

DELETE

	LONG-TERM-FATIGUE	...
	LONG-TERM-RESPONSE	...
	RESPONSE-CO-SPECTRUM	...
	RESPONSE-SPECTRUM	...
	RESPONSE-VARIABLE	...
	SHORT-TERM-RESPONSE	...
DELETE	SN-CURVE	...
	SPECIFIC-POINT	...
	SPEED-REDUCTION-DATA	...
	WAVE-SPECTRUM	...
	WAVE-SPREADING-FUNCTION	...
	WAVE-STATISTICS	...
	WORKABILITY-ANALYSIS	...

PURPOSE:

This is used to delete response types previously created.

The subcommands are mainly the same as for the corresponding CREATE commands. The program will ask for the name of a the response and delete all data stored under this name.

DELETE LONG-TERM-FATIGUE

| ... | LONG-TERM-FATIGUE | resp+ |

PURPOSE:

To delete long term fatigue for a given response variable.

PARAMETERS:

resp   Name of the response variable for which the long term fatigue shall be deleted.

DELETE LONG-TERM-RESPONSE

...	LONG-TERM-RESPONSE	RESPONSE-VARIABLE	resp+
		SLAMMING	point+

PURPOSE:

To delete long term response for a given response variable or long term slamming at a specific point.

PARAMETERS:

RESPONSE-VARIABLE	Long term response for a given response variable will be deleted.
resp	Name of the response variable for which the long term response shall be deleted.
SLAMMING	Long term slamming calculation will be deleted.
point	Name of the specific point where long term slamming shall be deleted.

DELETE RESPONSE-CO-SPECTRUM

| ... | RESPONSE-CO-SPECTRUM | number+ |

PURPOSE:

To delete a generated response cross spectrum.

PARAMETERS:

number   Reference number of the response cross spectrum. This reference number is generated by the program and may be examined by the PRINT OVERVIEW RESPONSE-CO-SPECTRUM command.

DELETE RESPONSE-SPECTRUM

| ... | RESPONSE-SPECTRUM | number+ |

PURPOSE:

To delete a generated response spectrum.

PARAMETERS:

number   Reference number of the response spectrum. This reference number is generated by the program and may be examined by the PRINT OVERVIEW RESPONSE-SPECTRUM command.

DELETE RESPONSE-VARIABLE

| ... | RESPONSE-VARIABLE | name+ |

PURPOSE:

To delete user created response variables. It is not possible to delete any response variables read from the Results Interface File.

PARAMETERS:

name   User given name of the response variable.

DELETE SHORT-TERM-RESPONSE

| ... | SHORT-TERM-RESPONSE | number+ |

PURPOSE:

To delete a generated short term response.

PARAMETERS:

number   Reference number of the short term response. This reference number is generated by the pro-
            gram and may be examined by the PRINT OVERVIEW SHORT-TERM-RESPONSE com-
            mand.

DELETE SN-CURVE

...	SN-CURVE	name+

PURPOSE:

To delete a user specified SN-curve.

PARAMETERS:

name   Name of the user specified SN-curve.

DELETE SPECIFIC-POINT

...	SPECIFIC-POINT	name+

PURPOSE:

To delete a specific point.

PARAMETERS:

name   Name of the point.

DELETE SPEED-REDUCTION-DATA

...	SPEED-REDUCTION-DATA	name+

PURPOSE:

To delete a speed-reduction curve.

PARAMETERS:

name   Name of the curve.

DELETE WAVE-SPECTRUM

| ... | WAVE-SPECTRUM | name+ |

PURPOSE:

To delete a wave spectrum.

PARAMETERS:

name   Name of the spectrum.

DELETE WAVE-SPREADING-FUNCTION

...	WAVE-SPREADING-FUNCTION	name+

PURPOSE:

To delete a wave energy spreading function.

PARAMETERS:

name   Name of the function.

DELETE WAVE-STATISTICS

| ... | WAVE-STATISTICS | name+ |

PURPOSE:

To delete a wave statistics model.

PARAMETERS:

name   Name of the wave statistics.

DELETE WORKABILITY-ANALYSIS

| ... | WORKABILITY-ANALYSIS | name+ |

PURPOSE:

To delete a workability analysis.

PARAMETERS:

name   Name of the workability analysis.

DISPLAY

DISPLAY	LONG-TERM-RESPONSE	...
	MATRIX	...
	REFRESH	...
	RESPONSE-CO-SPECTRUM	...
	RESPONSE-SPECTRUM	...
	RESPONSE-VARIABLE	...
	SECTIONAL-FORCE-DIAGRAM	...
	SHORT-TERM-RESPONSE	...
	SN-CURVE	...
	SPECIFIC-POINT	...
	SPEED-REDUCTION-CURVE	...
	WAVE-SPECTRUM	...
	WAVE-SPREADING-FUNCTION	...

PURPOSE:

To display selected functions or spectra on a graphical screen. The screen device may be altered by the SET DISPLAY DEVICE command.

DISPLAY LONG-TERM-RESPONSE

...	LONG-TERM-RESPONSE	...

				LOG-Q	dir+	
...	RESPONSE-VARIABLE	[body+]	resp+	WAVE-DIRECTION	prob	
	SLAMMING	[body+]	point+	LOG-Q	dir+	
				WAVE-DIRECTION	prob	
	SECTIONAL-FORCE-DIAGRAM	[body+]	dof	prob	dir+	lsec	usec

PURPOSE:

To display long term response for a selected response variable, long term slamming in a specific point or a sectional force diagram as a function of the section numbers.

PARAMETERS:

RESPONSE-VARIABLE	Long term response for a selected response variable is displayed.
SLAMMING	Long term slamming is displayed.
SECTIONAL-FORCE-DIAGRAM	A long term sectional force diagram will be displayed as force/moments against the section number. For a ship vessel, this will give the long term moment diagram over the ship length.
body	Optional body identification. Only if the presentation option is specified as several bodies in the same plot. Only available if **DEFINE PRESENTATION-OPTION SIMULTANEOUS-BODIES** is set to **ALL**
resp	Response variable for which the long term response is to be displayed.
point	Specific point where long term slamming is calculated.
dir	Wave direction.
LOG-Q	The abscissa axis will be the logarithm of the probability level used in the calculation.
WAVE-DIRECTION	The abscissa axis will be the wave directions used in the calculation.
prob	Probability level for which the long term response has been calculated.

dof	Degree of freedom for which the sectional force diagram will be displayed.
lsec	Lower sequence number on the sectional forces. This requires a sequence numbering from the Global Response Interface File.
usec	Upper sequence number on the sectional forces.

DISPLAY MATRIX

...	MATRIX	ADDED-MASS	[body+]	elem+
		POTENTIAL-DAMPING		
		TOTAL-DAMPING		

PURPOSE:

To display the frequency dependent matrices added mass, potential damping or total damping for a selected element in a 6x6 matrix.

PARAMETERS:

ADDED-MASS   Added mass matrix.

POTENTIAL-DAMPING   Potential damping matrix.

TOTAL-DAMPING   Total damping matrix.

body   Optional body identification if a multiple body solution is executed or several single body solutions exist. Both the body matrix and the coupling matrices will be available. Only available if **DEFINE PRESENTATION-OPTION SIMULTANE-OUS-BODIES** is set to **ALL**

elem   Element number in the matrix. The number must be specified as 2 digits, giving the row and column number in a 6x6 matrix. For instance the heave-heave element will be referred as **33** in the current body.

DISPLAY REFRESH

| ... | REFRESH |

PURPOSE:

To refresh the display on screen. The previous commands and selection are used in the refreshing. The user may change some presentation options, like the x-axis required, colour setting, grid on/off etc. The DIS-PLAY REFRESH command is identical to the PLOT command, except that it accesses the screen device.

DISPLAY RESPONSE-CO-SPECTRUM

...	RESPONSE-CO-SPECTRUM	[body+]	number+

PURPOSE:

To display one or several response spectra, of type cross spectrum, created by the program. Note that response spectra calculated by using general gamma spectrum are not available for display.

PARAMETERS:

body   Optional body identification. Only available if **DEFINE PRESENTATION-OPTION SI-MULTANEOUS-BODIES** is set to **ALL**.

number   Reference number of the response cross spectrum.

DISPLAY RESPONSE-SPECTRUM

...	RESPONSE-SPECTRUM	[body+]	number+

PURPOSE:

To display one or several response spectra, of type auto spectrum, created by the program. Note that response spectra calculated by using general gamma spectrum are not available for display. 7 response spectra can be displayed together.

PARAMETERS:

body   Optional body identification. Only available if **DEFINE PRESENTATION-OPTION SI-MULTANEOUS-BODIES** is set to **ALL**.

number   Reference number of the response spectrum.

DISPLAY RESPONSE-VARIABLE

...	RESPONSE-VARIABLE	[body+]	nam1+	dir+	Froude+
			SECOND-ORDER	...	

...	SURFACE	nam2	dir1	dir2	
	CONTOUR	nam2	dir1	dir2	
	GRAPH	nam2+	dir1+	dir2+	freq

PURPOSE:

To display one or several first order response variables or second order response variables in specified type of graph. First order response variables are presented as a function of frequency for a given wave direction. Second order response variables are presented as a function of two frequencies for two given wave directions, or as a linear cut in this function.

If the ordinate value of the first order response variable has been set to the real/imaginary part or the amplitude/phase, only the first body, response variable, wave direction (and Froude number) will be used (See DEFINE PRESENTATION-OPTION RESPONSE-VARIABLE ORDINATE).

PARAMETERS:

body	Optional body identification. Only available if DEFINE PRESENTATION-OPTION SIMULTANEOUS-BODIES is set to ALL.
SECOND-ORDER	Second order response variables will be presented against sum or difference frequency.
nam1	Name of first order response variable.
dir	Wave direction for first order response variable.
Froude	Optional Froude number. Only if several forward speeds are available.
SURFACE	Display the functional representation of one second order response variable as a 3D surface.
CONTOUR	Display the functional representation of one second order response variable as a contour plot.
GRAPH	Display the functional representation of one or more second order response variable as a linear cut in the two-dimensional function. The command DEFINE PRESENTATION-OPTION RESPONSE-VARIABLE SECOND-ORDER-GRAPH is used to determine how the cut in the function is done. See this command for a complete description of the available options. A maximum of 7 graphs can be presented together.
nam2	Name of second order response variable.

dir1   First wave direction for second order response variable.

dir2   Second wave direction for second order response variable.

freq   Fixed frequency value.

DISPLAY SECTIONAL-FORCE-DIAGRAM

...	SECTIONAL-FORCE-DIAGRAM	[body+]	dof	dir	...

...	freq+	lsec	usec	[Froude+]

PURPOSE:

Tp display a sectional force diagram as force/moments against the section number. For a ship vessel, this will give the moment diagram over the ship length. This is mainly used for ship models. If several bodies selected, only the first frequency (or Froude number) will be used.

PARAMETERS:

body   Optional body identification. Only available if DEFINE PRESENTATION-OPTION SI-MULTANEOUS-BODIES is set to ALL.

dof   Degree of freedom for which the sectional force diagram will be displayed.

dir   Wave direction for the transfer function.

freq   Selected angular frequencies.

lsec   Lower sequence number on the sectional forces. This requires a sequence numbering from the Global Response Interface File.

usec   Upper sequence number on the sectional forces.

Froude   Optional Froude number. Only if several forward speeds is available.

DISPLAY SHORT-TERM-RESPONSE

| ... | SHORT-TERM-RESPONSE | [body] | number+ |

PURPOSE:

To display one or several short term responses created by the program. A maximum of 7 short term responses can be displayed together.

PARAMETERS:

body Optional body identification. Only available if DEFINE PRESENTATION-OPTION SI-MULTANEOUS-BODIES is set to ALL.

number Reference number of the short term response.

DISPLAY SN-CURVE

...	SN-CURVE	name+

PURPOSE:

To display one or several SN-curves.

PARAMETERS:

name   Name of the SN-curve.

DISPLAY SPECIFIC-POINT

...	SPECIFIC-POINT	name+	XY-PLANE
			XZ-PLANE
			YZ-PLANE

PURPOSE:

To display one or several specific points in a given plane.

PARAMETERS:

name   Name of the point.

XY-PLANE   The points are displayed in the xy-plane.

XZ-PLANE   The points are displayed in the xz-plane.

YZ-PLANE   The points are displayed in the yz-plane.

DISPLAY SPEED-REDUCTION-CURVE

...	SPEED-RECUTION-CURVE	name+

PURPOSE:

To display one or several speed-reduction curves.

PARAMETERS:

name   Name of the curve.

DISPLAY WAVE-SPECTRUM

...	WAVE-SPECTRUM	name+

PURPOSE:

To display wave spectra created by the user.

PARAMETERS:

name   Name of the spectrum.

DISPLAY WAVE-SPREADING-FUNCTION

...	WAVE-SPREADING-FUNCTION	name	[space]

PURPOSE:

To display energy spreading for elementary wave directions created by the user.

PARAMETERS:

name   User given name of the function.

space   User input space between each wave direction angle for which the energy spreading function
                will be displayed. This space is independent of what

                the program will use in calculating the response spectra. Only asked for if the name of the
                function corresponds to a cosine power function.

FILE

FILE	EXIT	
	PLOT	
	READ	...

PURPOSE:

This command is used for file handling control, or to terminate the program execution.

FILE EXIT

...	EXIT

PURPOSE:

To exit from Postresp.

The termination of Postresp is also available as the main command EXIT in line mode. Note that EXIT cannot be abbreviated.

FILE PLOT

...	PLOT

PURPOSE:

Plot last display on hard copy device.

This command is also available as the main command PLOT in line mode.

FILE READ

...	READ	SIF-FORMATTED	prefix	name
		SIN-NORSAM		
		SIU-UNFORMATTED		
		WAMIT-RESULTS		

PURPOSE:

This command is used in the frequency domain part. It opens and reads the Hydrodynamic Results Interface File (G-file) containing a single or multiple body solution or a set of WAMIT results files. When complete the opened files will be closed.

The command may also be used to read external scatter diagrams from a file on Hydrodynamic Results Interface File format. The scatter diagrams can be directional or wave direction independent.

PARAMETERS:

SIF-FORMATTED   Hydrodynamic Results Interface File on formatted ASCII format.

SIN-NORSAM   Hydrodynamic Results Interface File on direct access format.

SIU-UNFORMATTED   Hydrodynamic Results Interface File on unformatted sequential format.

WAMIT-RESULTS   A standard set of WAMIT results files can be read. All files will have the same name, but different suffix corresponding to the WAMIT definitions.

Postresp requires that the file containing the excitation forces (<name>.2 or <name>.3) is present. In addition, the gravity and characteristic length should be fetched from the <name>.GDF file.

Do also remember to define the water density if it is not 1025 as the default in Postresp.

prefix   File name prefix.

name   Name of the Hydrodynamic Results Interface File or WAMIT files.

PLOT

PLOT

PURPOSE:

Plot last display on hard copy device. The previous commands and selection are used in the plotting. The user may change some presentation options, like the x-axis required, colour setting, grid on/off etc. This command is not available from the menubar in graphics mode. Use FILE PLOT instead.

PRINT

PRINT	DATA-SET	
	LIMITATIONS	
	LONG-TERM-FATIGUE	...
	LONG-TERM-RESPONSE	...
	MATRIX	...
	OVERVIEW	
	RESPONSE-CO-SPECTRUM	...
	RESPONSE-SPECTRUM	...
	RESPONSE-VARIABLE	...
	SECOND-ORDER-STATISTICS	...
	SHORT-TERM-FATIGUE	...
	SHORT-TERM-RESPONSE	...
	SHORT-TERM-STATISTICS	...
	SN-CURVE	...
	SPECIFIC-POINT	...
	SPEED-REDUCTION	...
	WAVE-SPECTRUM	...
	WAVE-SPREADING-FUNCTION	...
	WAVE-STATISTICS	...
	WORKABILITY-ANALYSIS	...

PURPOSE:

This is used to print selected information to the computer screen or on a print file.

Most of the subcommands available are the same as for the corresponding CREATE subcommands. In addition the user is offered several subcommands for printing a global or object dependent overview and program status information.

PRINT DATA-SET

| ... | DATA-SET |

PURPOSE:

This command gives a list of available bodies or data sets on the Postresp data base and which one of these that is current. It also prints the data card read from the Results Interface File, if any.

PRINT LIMITATIONS

| ... | LIMITATIONS |

PURPOSE:

This command gives a list of the current limitations in Postresp.

PRINT LONG-TERM-FATIGUE

...	LONG-TERM-FATIGUE	resp+	durat+	FULL			
				SUMMARY			
				WEIBULL-FIT	resp+	sn-curve	durat+

PURPOSE:

To print long term fatigue for a selected response variable directly (i.e. using a Rayleigh distribution), or based on an already existing long term response calculation based on a Weibull fit.

PARAMETERS:

WEIBULL-FIT	Long term fatigue will be calculated based on an existing long term response.
resp	Response variable(s) for which the long term fatigue is printed.
durat	User specified duration, in seconds for which the total damage shall be estimated.
sn-curve	Name of the SN-curve to be used.
FULL	Full print of results, including partial results for each cell in the scatter diagrams.
SUMMARY	Print summary of results. Partial results for each cell in the scatter diagrams are not printed.

EXAMPLES:

```
PRINT LONG-TERM-FATIGUE WEIBULL ( GRES1 GRES2 GRES3 ) DNV-X ( 15.5e7 3.1e8 15.5e8 )
```

PRINT LONG-TERM-RESPONSE

...	LONG-TERM-RESPONSE	RESPONSE-VARIABLE	resp+
		SLAMMING	point

PURPOSE:

To print long term response for a selected response variable or long term slamming in a specific point.

PARAMETERS:

RESPONSE-VARIABLE   Long term response for a selected response variable is printed.

SLAMMING   Long term slamming is printed.

resp   Response variable(s) for which the long term response(s) is printed.

point   Specific point where long term slamming has been calculated.

PRINT MATRIX

...	MATRIX	ADDED-MASS	[body]	FULL-MATRIX	freq
				SINGLE-ELEMENT	elem
		BODY-MASS			
		POTENTIAL-DAMPING	[body]	FULL-MATRIX	freq
				SINGLE-ELEMENT	elem
		RESTORING			
		TOTAL-DAMPING	[body]	FULL-MATRIX	freq
				SINGLE-ELEMENT	elem
		VISCOUS-DAMPING			

PURPOSE:

To print global matrices, either added mass and damping matrix as a function of the frequencies or the total matrix for a selected frequency, or print of the inertia coefficient (body mass) and restoring matrix.

PARAMETERS:

ADDED-MASS	Added mass matrix.
POTENTIAL-DAMPING	Potential damping matrix.
TOTAL-DAMPING	Total damping matrix.
VISCOUS-DAMPING	Viscous part of the damping matrix.
RESTORING	Hydrostatic restoring matrix.
BODY-MASS	Inertia coefficient (body-mass) matrix.
FULL-MATRIX	A 6x6 matrix for a given frequency will be printed.
SINGLE-ELEMENT	A single element of the matrix will be printed as a function of the angular frequencies.
body	Optional body identification. Only if a multiple body solution is executed. Both the body matrix and the coupling matrices are available.
freq	Selected angular frequency.
elem	Element number in the matrix. The number must be specified as 2 digits, giving the row and column number in a 6x6 matrix. For instance the heave-heave element will be referred as 33.

PRINT OVERVIEW

...	OVERVIEW	ALL
		LONG-TERM-RESPONSE
		MATRIX
		RESPONSE-CO-SPECTRUM
		RESPONSE-SPECTRUM
		RESPONSE-VARIABLE
		SHORT-TERM-RESPONSE
		SPECIFIC-POINT
		WAVE-SPECTRUM
		WAVE-SPREADING-FUNCTION
		WAVE-STATISTICS
		WORKABILITY-ANALYSIS

PURPOSE:

This command gives a table containing an overview of the total number of each response available in the Postresp data base or an overview of each object with names and descriptive text.

PARAMETERS:

ALL   Global overview of total number of each response available in the current data set. Also print any text records read from the Response Interface File.

LONG-TERM-RESPONSE   Overview of the long term responses created.

MATRIX   Overview of the global matrices.

RESPONSE-CO-SPECTRUM   Overview of the cross spectra created.

RESPONSE-SPECTRUM   Overview of the response spectra created.

RESPONSE-VARIABLE   Overview of the response variables created.

SHORT-TERM-RESPONSE   Overview of the short term responses created.

SPECIFIC-POINT   Overview of the specific points created.

WAVE-SPECTRUM   Overview of the wave spectra created.

WAVE-SPREADING-FUNCTION   Overview of the wave energy spreading functions created.

WAVE-STATISTICS   Overview of the wave statistics models created.

WORKABILITY-ANALYSIS   Overview of the workability analysis created.

PRINT RESPONSE-CO-SPECTRUM

...	RESPONSE-CO-SPECTRUM	number+	
		DUMP-SPECTRUM	number

PURPOSE:

To print calculated response cross spectra. Only the spectrum characteristics, such as the spectrum period and moments will be printed, unless the user asks for a dump.

The dump is not available for a response spectrum calculated with a general gamma spectrum.

PARAMETERS:

number	Reference number of the response cross spectrum.
DUMP-SPECTRUM	A response spectrum for given reference number will be dumped, i.e. spectrum ordinates for 201 frequencies will be printed.

PRINT RESPONSE-SPECTRUM

...	RESPONSE-SPECTRUM	number+	
		DUMP-SPECTRUM	number

PURPOSE:

To print calculated auto response spectra. Only the spectrum characteristics, such as the spectrum period and moments will be printed, unless the user asks for a dump.

The dump is not available for a response spectrum calculated with a general gamma spectrum.

PARAMETERS:

number   Reference number of the response spectrum.

DUMP-SPECTRUM   A response spectrum for given reference number will be dumped, i.e. spectrum or-
                    dinates for 201 frequencies will be printed.

PRINT RESPONSE-VARIABLE

...	RESPONSE-VARIABLE	nam1+		dir+		
		SECOND-ORDER	nam2	dir1+	dir2+	

PURPOSE:

To print first or second order response variables.

PARAMETERS:

SECOND-ORDER	Second order response variables will be printed.
nam1	Name of the first order response variable.
dir	Wave direction for the first order response variable.
nam2	Name of the second order response variable.
dir1	First wave direction for the second order response variable.
dir2	Second wave direction for the second order response variable.

PRINT SECOND-ORDER-STATISTICS

...	SECOND-ORDER-STATISTICS	DIFFERENCE	...	FIRST-ORDER-INCLUDED	...
		SUM			
		ALL		SECOND-ORDER-ONLY	

...	option	spec	sprea	dir	prob

PURPOSE:

To calculate and print the response statistics for pure second order or combined first and second order responses. The print table provides the mean, standard deviation, skewness, kurtosis, and maximum and minimum extreme levels for a specified set of probabilities.

PARAMETERS:

DIFFERENCE	Use only difference frequency QTF to represent second order response.
SUM	Use only sum frequency QTF to represent second order response.
ALL	Use both sum and difference frequency QTFs to represent second order response.
SECOND-ORDER-ONLY	Exclude first order effects from reported statistics.
FIRST-ORDER-INCLUDE	Include the first order and mixed first and second order contributions to the reported statistics.
option	Specifies for what the second order statistics are to be calculated. For the time being, only the excitation forces are available. The options for forces are:
	EXCITATIONFORCE-1, EXCITATIONFORCE-2, EXCITATIONFORCE-3,
	EXCITATIONFORCE-4, EXCITATIONFORCE-5, EXCITATIONFORCE-6
	If first order effects are to be included the corresponding first order force is selected automatically from:
	FORCE1, FORCE2, FORCE3, FORCE4, FORCE5, FORCE6
spec	Name of the wave spectrum to be used in the calculations.
sprea	Name of the wave spreading function to be used. Must be given as NONE if short crested sea is required.

dir   Main wave direction.

prob*   Probabilities of exceedance for which the maximum and mini-
                                           mum response levels are requested.

EXAMPLES:

```
PRINT SECOND-ORDER-STATISTICS ALL FIRST-ORDER-INCLUDED EXCITATIONFORCE-1
PM1 NONE 0.0 ( 0.001 0.0001 )
```

PRINT SHORT-TERM-FATIGUE

...	SHORT-TERM-FATIGUE	durat+	spec+	sn-curve

PURPOSE:

To calculate and print short term fatigue for several response spectra using a specified SN-curve and a Rayleigh distribution function.

PARAMETERS:

durat   User specified duration, in seconds for which the total damage shall be estimated.

spec   Response spectrum reference number for which the short term fatigue is to be calculated.

sn-curve   Name of the user specified SN-curve.

EXAMPLES:

```
PRINT SHORT-TERM-FATIGUE ( 10800 ) ( 1 2 3 ) DNV-X
```

PRINT SHORT-TERM-RESPONSE

...	SHORT-TERM-RESPONSE	number+

PURPOSE:

To print short term response calculated for a set of Tz-values.

PARAMETERS:

number   Reference number of the short term response.

PRINT SHORT-TERM-STATISTICS

...	SHORT-TERM-STATISTICS	RAYLEIGH	...
		RICE	

...	RESPONSE-LEVEL	level*	spec+
	PROBABILITY-OF-EXCEEDANCE	prob*	spec+
	SEA-STATE-DURATION	durat*	spec+

PURPOSE:

To calculate and print short term statistics for several response spectra. The distribution functions available are either a Rayleigh or a Rice function. The user can have the prediction after either a given response level, a given probability of exceedance or for a given sea state duration.

PARAMETERS:

RAYLEIGH
Rayleigh distribution function will be used on the wave peaks.

RICE
Rice distribution function will be used on the wave peaks with the spreading parameter (epsilon) as in the response spectrum chosen.

RESPONSE-LEVEL
Response level given, for which the probability of exceedance is requested.

PROBABILITY-OF-EXCEEDANCE
Probability of exceedance is given, the response level referring to this will be printed.

SEA-STATE-DURATION
User given sea state duration. The program will print total number of zero upcrossings, the probability of exceedance and the corresponding response level.

level
Response level for which the probability of exceedance is requested.

prob
Probability of exceedance given for which the response level is requested.

durat
Sea state duration (in seconds).

spec
Response spectrum reference number for which the short term statistics is to be performed on.

EXAMPLES:

```
PRINT SHORT-TERM-STATISTICS RAYLEIGH SEA-STATE-DURATION ( 10800 ) ( 1 2 3 )
PRINT SHORT-TERM-STATISTICS RAYLEIGH RESPONSE-LEVEL ( 6.0 ) ( 1 2 3 )
```

```
PRINT SHORT-TERM-STATISTICS RAYLEIGH PROBABILITY-OF-EXCEEDANCE (0.0001) (1 2 3)
```

PRINT SN-CURVE

...	SN-CURVE	name+

PURPOSE:

To print data related to an SN-curve.

PARAMETERS:

name   Name of the SN-curve.

PRINT SPECIFIC-POINT

...	SPECIFIC-POINT	name+

PURPOSE:

To print specific points defined in Postresp or read from the Hydrodynamic Results Interface File (G-file).

PARAMETERS:

name   Name of the point.

PRINT SPEED-REDUCTION

...	SPEED-REDUCTION	name+

PURPOSE:

To print speed-reduction curves.

PARAMETERS:

name   Name of the curve.

PRINT WAVE-SPECTRUM

...	WAVE-SPECTRUM	name+	
		DUMP-SPECTRUM	name

PURPOSE:

To print defined and calculated wave spectra. Only the spectrum characteristics, such as the spectrum period and moments will be printed, unless the user asks for a dump.

Note that for a general gamma spectrum, only the user input are available due to the fact that the wave spectrum it self will not be calculated.

PARAMETERS:

name	Name of the spectrum.
ALL	All wave spectra are printed.
DUMP-SPECTRUM	The selected wave spectrum name will be dumped, i.e. spectrum ordinates for 201 frequencies will be printed.

PRINT WAVE-SPREADING-FUNCTION

| ... | WAVE-SPREADING-FUNCTION | name+ | [space] |

PURPOSE:

To print energy spreading for elementary wave directions.

PARAMETERS:

name   Name of the function.

space   User input space between each wave direction angle for which the energy spreading function
              will be printed. This space is independent of what the program will use in calculating the re-
              sponse spectra. Only asked for if one of the names selected corresponds to a cosine power
              function.

PRINT WAVE-STATISTICS

...	WAVE-STATISTICS	name

PURPOSE:

To print wave statistics defined.

PARAMETERS:

name   Name of the wave statistics.

PRINT WORKABILITY-ANALYSIS

| ... | WORKABILITY-ANALYSIS | name+ |

PURPOSE:

To print workability analysis created.

PARAMETERS:

name   Name of the workability analysis.

RUN

RUN	EQUATION-SOLVER	dir+	freq+
			ORIGINAL-FREQUENCIES

PURPOSE:

The command is used to solve the equation of motion for selected frequencies or for the original frequencies for which the matrices are given.

Note that the frequencies have to be given within the range of frequencies for the matrices, i.e. Postresp will not perform extrapolations.

PARAMETERS:

EQUATION-SOLVER   The motion of equation will be solved.

dir   Wave direction to be included in the solution.

ORIGINAL-FREQUENCIES   The motion of equation will be solved for all frequencies for which the matrices are given.

freq   Selected angular frequency.

SELECT

SELECT	DATA-SET	name

PURPOSE:

Used to select between data set or bodies.

PARAMETERS:

DATA-SET   Selection of data set or body in frequency domain.

name   Name of the data set or body if multiple body solution.

SET

SET	COMPANY-NAME	...
	DISPLAY	...
	DRAWING	...
	GRAPH	...
	PRINT	...
	PLOT	...
	TITLE	...

PURPOSE:

Set options that apply generally to print and display/plot.

SET COMPANY-NAME

...	COMPANY-NAME	name

PURPOSE:

Set the company name for use with result presentation.

PARAMETERS:

name   The name of the company.

NOTES:

The name is used at the top of a framed display/plot (see SET DRAWING FRAME). It is not used with printed results.

EXAMPLES:

```
SET COMPANY-NAME 'Det Norske Veritas Software'
```

SET DISPLAY

...	DISPLAY	COLOUR	ON			
			OFF			
		DESTINATION	SCREEN			
			FILE			
		DEVICE	device			
		WORKSTATION-WINDOW	left	right	bottom	top

PURPOSE:

Set options that affect the display of data.

PARAMETERS:

COLOUR

Turn colour on/off in the display. Note that display and plot colour options may be different.

DESTINATION

Show the display on the SCREEN or send it to a FILE.

device

Set the display device. If the device is not correct, the display will appear as a lot of strange characters on the screen, and probably demand that a <Return> is typed before it appears. The display device is ignored if the display destination is to file. The actual list of available devices depend on the installation. Some, but not necessarily all, of these could be available:

3279, APOLLO, CDC-721, TPAZ-MONO, TPAZ-COLOUR, TX4014-15-16-54, TX4105,

TX4107-09-13-15, VT125, VT240, VT340, WESTWARD-3219, WESTWARD-3220,

VAXSTATION-UIS, X-WINDOW, DUMMY

The DUMMY device is used to do a display command without generating a display.

WORKSTATION-WINDOW

Set the size of the display window. This command will only work when running under X-windows and on an Apollo workstation. In addition, the window size must be set before the window is opened.

left

The left edge of the window. Must be in the range from 1 to 120.

right	The right edge of the window. Must be in the range from 1 to 120.
bottom	The bottom edge of the window. Must be in the range from 1 to 100.
top	The top edge of the window. Must be in the range from 1 to 100.

NOTES:

The DESTINATION FILE option is useful for making a journal file run in batch mode. Edit the setting into the top of the file, and all displays will be written to file instead of shown on the screen. No other changes need be made. Another possibility is to set the device to DUMMY, which will make all display commands execute without generating displays.

The DESTINATION is always set to SCREEN when Postresp starts up, regardless of the status it may have been set to in a previous run.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET DISPLAY COLOUR ON
SET DISPLAY DESTINATION SCREEN
SET DISPLAY DEVICE TX4014-15-16-54                    (if running in line mode)
SET DISPLAY DEVICE X-WINDOW                        (if running in graphics mode)
SET DISPLAY WORKSTATION-WINDOW  60  120  40  100
```

SET DRAWING

...	DRAWING	CHARACTER-TYPE	HARDWARE	
			SOFTWARE	
		FONT-SIZE	ABSOLUTE	width
			RELATIVE	factor
		FONT-TYPE	SIMPLE	
			GROTESQUE	
			ROMAN-NORMAL	
			ROMAN-ITALIC	
			ROMAN-BOLD	
		FRAME	ON	
			OFF	
		GRID	ON	
			OFF	

PURPOSE:

Set attributes of drawings.

PARAMETERS:

CHARACTER-TYPE	The character type can be either SOFTWARE (i.e. scalable) or HARDWARE (i.e. fixed).
FONT-SIZE	Select the font size.
width	Set font width.
factor	Set scaling factor.
FONT-TYPE	Select the font to be used. The list of fonts may be machine dependent.
FRAME	Turn the frame of the display and plot on/off. The framed plot is roughly A4 size on paper, while the unframed plot is somewhat smaller. On the screen they will fit into the same window, so the framed display will be smaller than the unframed plot. The titles and company name will only appear when the frame is on.
GRID	Turn the drawing of a dotted grid on/off in an xy-plot. Does not apply to pie chart plots.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET DRAWING CHARACTER-TYPE SOFTWARE
SET DRAWING FONT-SIZE ABSOLUTE 2.0
SET DRAWING FONT-TYPE SIMPLE
SET DRAWING FRAME OFF
SET DRAWING GRID ON
```

SET GRAPH

...	GRAPH	LINE-OPTIONS	...
		XAXIS-ATTRIBUTES	...
		YAXIS-ATTRIBUTES	...
		ZAXIS-ATTRIBUTES	...

PURPOSE:

Set options that apply to graphs.

SUBCOMMANDS:

LINE-OPTIONS   Set options controlling how lines are drawn and marked (not active in Postresp).

XAXIS-ATTRIBUTES   Set options controlling the drawing and scale of the x-axis

YAXIS-ATTRIBUTES   Set options controlling the drawing and scale of the y-axis

ZAXIS-ATTRIBUTES   Set options controlling the drawing and scale of the z-axis

SET GRAPH LINE-OPTIONS

...	LINE-OPTIONS	LINE-TYPE	line	BLANK
				END-POINT
				DASHED
				DASH-DOT
				DEFAULT
				DOTTED
				SOLID
		MARKER		ON
				OFF
		MARKER-TYPE	line	CROSS
				DEFAULT
				DELTA
				DIAMOND
				NABLA
				PLUS
				SQUARE
		MARKER-SIZE	size	

PURPOSE:

Set options controlling how lines are drawn and marked.

PARAMETERS:

LINE-TYPE   Controls how lines are drawn. Only six lines can be controlled.

line   A line number, from 1 to 6.

MARKER   Turn usage of markers on/off.

MARKER-TYPE   Control the marker type for up to six lines.

MARKER-SIZE   Set the size of the markers.

size   The size of the markers.

SET GRAPH XAXIS-ATTRIBUTES

...	XAXIS-ATTRIBUTES	DECIMAL-FORMAT	EXPONENTIAL		
			FIXED		
			GENERAL		
			INTEGER		
		LIMITS	FREE		
			FIXED	xmin	xmax
		SPACING	LINEAR		
			LOGARITHMIC		
		TITLE	DEFAULT		
			SPECIFIED	xtitle	

PURPOSE:

Set options controlling the attributes of the x axis in a graph.

PARAMETERS:

DECIMAL-FORMAT   Controls the presentation of numbers labelling the x axis. The numbers can be presented in EXPONENTIAL format, in FIXED format, as INTEGERs or in GENERAL (free) format.

LIMITS   Controls the limits of the x axis. These can either be FREE (i.e. determined by the data that are being presented) or FIXED to the min value <xmin> and the max value <xmax>.

SPACING   Controls the spacing of numbers along the axis. The axis can have a LINEAR spacing or be LOGARITHMIC with base 10.

TITLE   The title at the x axis can be specified by Postresp (DEFAULT) or overridden with a SPECIFIED text: <xtitle>.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET GRAPH XAXIS-ATTRIBUTES DECIMAL-FORMAT GENERAL
SET GRAPH XAXIS-ATTRIBUTES LIMITS FREE
SET GRAPH XAXIS-ATTRIBUTES SPACING LINEAR
SET GRAPH XAXIS-ATTRIBUTES TITLE DEFAULT
```

SET GRAPH YAXIS-ATTRIBUTES

			EXPONENTIAL		
		DECIMAL-FORMAT	FIXED		
			GENERAL		
			INTEGER		
...	YAXIS-ATTRIBUTES	LIMITS	FREE		
			FIXED	ymin	ymax
		SPACING	LINEAR		
			LOGARITHMIC		
		TITLE	DEFAULT		
			SPECIFIED	ytitle	

PURPOSE:

Set options controlling the attributes of the y axis in a graph.

PARAMETERS:

DECIMAL-FORMAT   Controls the presentation of numbers labelling the y axis. The numbers can be presented in EXPONENTIAL format, in FIXED format, as INTEGERs or in GENERAL (free) format.

LIMITS   Controls the limits of the y axis. These can either be FREE (i.e. determined by the data that are being presented) or FIXED to the min value <ymin> and the max value <ymax>.

SPACING   Controls the spacing of numbers along the axis. The axis can have a LINEAR spacing or be LOGARITHMIC with base 10.

TITLE   The title at the y axis can be specified by Postresp (DEFAULT) or overridden with a SPECIFIED text: <ytitle>.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET GRAPH YAXIS-ATTRIBUTES DECIMAL-FORMAT GENERAL
SET GRAPH YAXIS-ATTRIBUTES LIMITS FREE
SET GRAPH YAXIS-ATTRIBUTES SPACING LINEAR
SET GRAPH YAXIS-ATTRIBUTES TITLE DEFAULT
```

SET GRAPH ZAXIS-ATTRIBUTES

...	ZAXIS-ATTRIBUTES	DECIMAL-FORMAT	EXPONENTIAL		
			FIXED		
			GENERAL		
			INTEGER		
		LIMITS	FREE		
			FIXED	zmin	zmax
		SPACING	LINEAR		
			LOGARITHMIC		
		TITLE	DEFAULT		
			SPECIFIED	ztitle	

PURPOSE:

Set options controlling the attributes of the z axis in a graph.

PARAMETERS:

DECIMAL-FORMAT   Controls the presentation of numbers labelling the z axis. The numbers can be presented in EXPONENTIAL format, in FIXED format, as INTEGERs or in GENERAL (free) format.

LIMITS   Controls the limits of the z axis. These can either be FREE (i.e. determined by the data that are being presented) or FIXED to the min value <zmin> and the max value <zmax>.

SPACING   Controls the spacing of numbers along the axis. The axis can have a LINEAR spacing or be LOGARITHMIC with base 10.

TITLE   The title at the z axis can be specified by Postresp (DEFAULT) or overridden with a SPECIFIED text: <ztitle>.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET GRAPH ZAXIS-ATTRIBUTES DECIMAL-FORMAT GENERAL
SET GRAPH ZAXIS-ATTRIBUTES LIMITS FREE
SET GRAPH ZAXIS-ATTRIBUTES SPACING LINEAR
SET GRAPH ZAXIS-ATTRIBUTES TITLE DEFAULT
```

SET PLOT

...	PLOT	COLOUR		ON
				OFF
		FILE	prefix	name
		FORMAT	...	
		PAGE-SIZE		A1
				A2
				A3
				A4
				A5

PURPOSE:

Set options that affect the writing of plot to file.

PARAMETERS:

COLOUR   Turn colour on/off in the plot. Note that display and plot colour options may be different.

FILE prefix name   Set the plot file name and prefix. The total file name is the concatenation of <prefix> and <name> and an extension determined by the plot format.

FORMAT format   Set the plot format.

PAGE-SIZE   Set the size of the plot.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET PLOT COLOUR ON
SET PLOT FILE  % the prefix and name of the database and journal file are defaults.
SET PLOT FORMAT SESAM-NEUTRAL
SET PLOT PAGE-SIZE A4
```

SET PLOT FORMAT

...	FORMAT	SESAM-NEUTRAL
		POSTSCRIPT
		HPGL-7550
		WINDOWS-PRINTER
		HPGL-2
		CGM-BINARY

PURPOSE:

Set the plot format. The actual list of available devices depend on the installation. Some, but not necessarily all, of these could be available.

PARAMETERS:

SESAM-NEUTRAL   Sesam Neutral format. This is the default format.

POSTSCRIPT   PostScript format (PostScript is a trademark of Adobe Systems Incorporated). Note that this requires access to a printer that accepts PostScript files.

HPGL-7550   HP 7550 plotter file format.

WINDOWS-PRINTER   Send plot directly to the default printer (defined in Windows).

HPGL-2   HP GL 2 plotter file format.

CGM-BINARY   CGM binary plot file format (can be imported into word processors).

EXAMPLES:

The following option is default when Postresp starts up with a new database:

```
SET PLOT FORMAT SESAM-NEUTRAL
```

SET PRINT

...	PRINT	DESTINATION		CSV-FILE
				FILE
				SCREEN
		FILE	prefix	name
		SCREEN-HEIGHT	nlines	
		PAGE-ORIENTATION		LANDSCAPE
				PORTRAIT

PURPOSE:

Set options that affect print.

PARAMETERS:

DESTINATION	To set the print destination to screen or print file, ordinary text file or 'comma separated values' file.
CSV-FILE	Direct print to the 'comma separated values' print file.
FILE	Direct print to the print file.
SCREEN	Direct print to the screen.
FILE prefix name	Set the print file name and prefix. The total file name is the concatenation of <prefix> and <name> and the extension ".lis".
SCREEN-HEIGHT nlines	Set the number of lines per screen page.
PAGE-ORIENTATION	Set the orientation of the print in the print file.
LANDSCAPE	Will use up to 132 characters horizontally.
PORTRAIT	Will use at most 80 characters horizontally.

NOTES:

The SCREEN-HEIGHT is by default set to 24 lines. This number is reset every time Postresp starts up, even if it had been set to another value in a previous run.

When running in graphics mode the print in the print window may look cleaner if the SCREEN-HEIGHT is set quite large, e.g. to 100.

The DESTINATION is reset to SCREEN every time Postresp starts up, even if it had been set to another value in a previous run.

The CSV-FILE option gives the same print as the FILE destination option, but a semicolon is inserted as delimiter between each column in the print table. The print will contain the print introduction page and page break inclusive table nomenclature at top of each print table. It is therefore recommended to print each wanted data table to separate files and remove additional information above the table prior to e.g. importing the table data into Microsoft Excel. The file name will get the extension '.csv'. This print option sets the (maximum) number of lines for each print table to 100000. Use this option only in connection with PAGEO-RIENTATION LANDSCAPE.

EXAMPLES:

The following options are default when Postresp starts up with a new database:

```
SET PRINT DESTINATION SCREEN
SET PRINT FILE  % the prefix and name of the database and journal file are defaults.
SET PRINT SCREEN-HEIGHT  %  see NOTES above.
SET PRINT PAGE-ORIENTATION PORTRAIT
```

SET TITLE

...	TITLE	{text}*4

PURPOSE:

Set user defined titles to be used with print and display/plot.

PARAMETERS:

text   Give four lines defining the plot title. The display layout will not accept more than 40 characters in each title.

NOTES:

The user titles are blank when Postresp starts up with a new database.

EXAMPLES:

```
SET TITLE 'Project name' 'Analysis no. 2' 'Line #3' 'Line #4'
```

APPENDIX A   TUTORIAL EXAMPLES

A 1   FLOATING BARGE

This example shows the use of the most common features in Postresp. That is, defining statistical tools such as wave spectra, wave spreading functions and long term wave statistics, and generation of response spectra, short term responses and long term responses.

The global results used in this example is generated by Wadam. A panel model is used for a simple floating barge with a total length of 50 meters and a distributed mass model taken from the panel model. The transfer functions on the Results Interface File are given for the following response variables:

- 6 first order rigid body motions.

- 6 first order wave exciting forces.

- 10 sections with 6 force components on each section. That is, 60 sectional loads.

All these transfer functions are given for:

- 20 wave lengths, from 46.75 to 881.14 meters. These values are incremented logarithmic because this run has been used to compare Postresp results with the old statistical program NV1473 which requires a logarithmic wave length spacing.

- 5 wave directions, 0, 45, 90, 135 and 180 degrees.

Further main input data used are:

- Water depth: 250 meters.

- Characteristic length: 50 meters.

Two response variables have been used in the example, HEAVE and PITCH motion. The response spectra, short term responses and the long term responses have been calculated and both printed and plotted. Some of the statistical tools defined and used are also printed and plotted. The journal file used and the print and plots generated are given on the following pages.

```
%     Postresp Users Manual tutorial example A1
%
%     Create wave spreading function named COS2:
%
 CREATE
  WAVE-SPREADING COS2 ' ' COS 2
%
%     Create a set of Pierson-Moskowitz spectra for Tz=5.0 to 15.0
%     seconds. The spectra will be named FRPM1,FRPM2 ... FRPM21:
%
 CREATE
  WAVE-SPECTRUM FRPM ' ' PIERSON-MOSKOWITZ  FULL 5. 15. 0.5
%
%     Create a point, named SP, on the barge where an absolute
%     combined motion response will be created. The point is located
%     on the section number 3, used by the analysis program Wadam.
%
 CREATE
  SPECIFIC-POINT SP ' ' -12.0 0 -1.5
%
%     Create a wave statistics model for describing the long term
%     condition of the sea. The wave statistics model is based on
%     Nordenstrom's theory and named NOR1:
%
 CREATE
  WAVE-STAT NOR1
   'NORDENSTROM MODEL FOR WAVE STATISTICS'
   NORDENSTROM
   ( 4.5 .119 1. 0.25 0.63
     6.5 .3455 1.35 0.85 0.85
     8.5 .3586 1.1 2.05 1.13
     10.5 .1385 0.75 3.3 1.56
     12.5 .029 0.35 5.0 1.82
     14.5 .005 0.2 6.15 2.02
     16.5 .001 0.0 6.3 1.86
     18.5 .0028 0.35 2.0 0.85 )
   20 LOG-NORMAL 3 2.83 0.44 0.12
   11 21.0 1.68 0.75 0.1429
%
%     Create a global combined motion response in the predefined point
%     SP and a general force load combination in section 3. The new
%     response variables are called ADISZSP and SPLITSP.
%
 CREATE
  RESPONS-VARIABLE
   ADISZSP ' ' COMBINED-MOTION SP * DISPLACEMENT ABSOLUTE Z
 CREATE
  RESPONS-VARIABLE
   SPLITSP ' ' GENERAL-COMB ( SECL31 1 SECL35 -1.5 )
%     Create a response spectrum for the response variables HEAVE and
%     PITCH, for the main wave directions 0, 45 and 90 degrees, and
%     for both long and short crested sea. The wave spectrum used is
```

```
%     FRPM11, which corresponds to TZ=10.0 seconds. There will be
%     generated 12 response spectra:
%
 CREATE
  RESPONSE-SPECTRUM
   ( HEAVE PITCH ) (0 45 90) FRPM11 NONE
 CREATE
  RESPONSE-SPECTRUM
   ( HEAVE PITCH ) (0 45 90) FRPM11 COS2
%
%     Create a short term response for the response variables HEAVE and
%     PITCH, for the main wave directions 0, 45 and 90 degrees, and for
%     both long and short crested sea. The wave spectrum type used is
%     Pierson-Moskowitz with a Tz-range from 5.0 to 15.0 seconds. There
%     will be generated 12 short term responses:
 CREATE
  SHORT-TERM-RESPONSE
   ( HEAVE PITCH ) (0 45 90) FRPM 1 21 NONE
 CREATE
  SHORT-TERM-RESPONSE
   ( HEAVE PITCH ) (0 45 90) FRPM 1 21 COS2
%
%     Assign probability and wave statistic model to each wave direction
%     to be used in long term response.
%
 ASSIGN WAVE-DIRECTION-PROBABILITY 0.0 0.125
 ASSIGN WAVE-DIRECTION-PROBABILITY 45.0 0.25
 ASSIGN WAVE-DIRECTION-PROBABILITY 90.0 0.25
 ASSIGN WAVE-DIRECTION-PROBABILITY 135.0 0.25
 ASSIGN WAVE-DIRECTION-PROBABILITY 180.0 0.125
%
 ASSIGN WAVE-STATISTICS 0.0 NOR1
 ASSIGN WAVE-STATISTICS 45.0 NOR1
 ASSIGN WAVE-STATISTICS 90.0 NOR1
 ASSIGN WAVE-STATISTICS 135.0 NOR1
 ASSIGN WAVE-STATISTICS 180.0 NOR1
%
 ASSIGN WAVE-SPREADING-FUNCTION NOR1  COS2 ALL
 ASSIGN WAVE-SPECTRUM           NOR1 PIERSON-MOSKOWITZ  ALL
%     Create a long term response for the response variables HEAVE and
%     PITCH, for the main wave directions 0, 45, 90 degrees.
%
 CREATE
  LONG-TERM-RESPONSE RESPONSE-VARIABLE ( HEAVE PITCH ) *
%
%     Change print unit from default screen to a file named APP_A:
%
 SET PRINT DESTINATION FILE
 SET PRINT PAGE-ORIENTATION LANDSCAPE
 SET PRINT FILE []
 APP_A
%
```

```
%     Set common text in the heading of each plot:
%
 SET TITLE
 'Turtorial example for Postresp Users Manual'  ' '  ' '  ' '
%
%     Print sequence:
%         - total overview.
%         - all wave spectra defined.
%         - wave spreading function named COS2, spacing = 45 degrees.
%         - wave statistics named NOR1.
%         - response variable HEAVE, with all headings.
%         - all response spectra created.
%         - all short term responses created.
%         - short term statistics for all response spectra created, with
%           a Rayleigh distribution and for 3 given sea state durations.
%         - long term response for HEAVE motion, with 5 return periods.
%
 PRINT  OVERVIEW ALL
 PRINT  WAVE-SPECTRUM *
 PRINT  WAVE-SPREADING-FUNCTION COS2 45
 PRINT  WAVE-STATISTICS  NOR1
 PRINT  RESPONS-VARIABLE  HEAVE *
 PRINT  RESPONSE-SPECTRUM *
 PRINT  SHORT-TERM-RESPONSE *
 PRINT  SHORT-TERM-STATISTICS RAYLEIGH
 SEA-STATE-DURATION
   ( 3600 10800 108000 )
   (  1 2 3 7 8 9 4 5 6 10 11 12 )
 PRINT LONG-TERM-RESPONSE RESPONSE-VARIABLE HEAVE
%     Plot sequence:
%     Before each plot, a user defined text is given to describe the
%     plot in a proper way:
%         - wave spectrum named FRPM11.
%         - wave spreading function named COS2.
%         - response variables HEAVE, PITCH, ADISZSP and SPLITSP with
%           headings 0, 45 and 90 degrees in each plot. HEAVE and PITCH
%           are given for angular frequency, period and wave length.
%         - all response spectra created.
%         - all short term responses created.
%         - long term response for HEAVE and PITCH with headings
%           0, 45, 90 degrees and all headings included. The plots are
%           given both as a function of LOG(Q) and wave headings.
%
  SET DISPLAY DEVICE X-WINDOW
  SET DISPLAY DESTINATION FILE
  SET PLOT FORMAT POSTSCRIPT
%
  SET TITLE
 'Wave spectrum used in response spectra'  ' '  ' '  ' '
  DISPLAY WAVE-SPECTRUM FRPM11
  SET TITLE
 'Wave spreading used for short crested sea'  ' '  ' '  ' '
```

```
  DISPLAY WAVE-SPREADING-FUNCTION COS2 45
%
% Response variables as functions of angular frequency (default),
% wave - length and period.
%
 SET TITLE
 'Transfer function for first order motion'  ' '  ' '  ' '
%
% Response variables as functions of angular frequency.
%
 DISPLAY RESPONSE-VARIABLE HEAVE (0 45 90)
 DISPLAY RESPONSE-VARIABLE PITCH (0 45 90)
 DISPLAY RESPONSE-VARIABLE ADISZSP (0 45 90)
 DISPLAY RESPONSE-VARIABLE SPLITSP (0 45 90)
%
%    Response variable as function of wave length.
%
 DEFINE PRESENTATION-OPTION ABSCISSA-AXIS
 WAVE-LENGTH
 DISPLAY RESPONSE-VARIABLE HEAVE (0 45 90)
 DISPLAY RESPONSE-VARIABLE PITCH (0 45 90)
%
%    Response variable as function of period.
%
 DEFINE PRESENTATION-OPTION ABSCISSA-AXIS
 PERIOD
 DISPLAY RESPONSE-VARIABLE HEAVE (0 45 90)
 DISPLAY RESPONSE-VARIABLE PITCH (0 45 90)
%    Reset abscissa axis to angular frequency.
%
 DEFINE PRESENTATION-OPTION ABSCISSA-AXIS ANGULAR-FREQUENCY
%
 SET TITLE
 'Response spectra for HEAVE, long crested sea'  ' '  ' '  ' '
 DISPLAY RESPONSE-SPECTRUM  ( 1 2 3 )
%
 SET TITLE
 'Response spectra for HEAVE, short crested sea'  ' '  ' '  ' '
 DISPLAY RESPONSE-SPECTRUM  ( 7 8 9 )
%
 SET TITLE
 'Response spectra for PITCH, long crested sea'  ' '  ' '  ' '
 DISPLAY RESPONSE-SPECTRUM  ( 4 5 6 )
%
 SET TITLE
 'Response spectra for PITCH, short crested sea'  ' '  ' '  ' '
 DISPLAY RESPONSE-SPECTRUM  ( 10 11 12 )
%
 SET TITLE
 'Short term resp for HEAVE, long crested sea'  ' '  ' '  ' '
 DISPLAY SHORT-TERM-RESPONSE (  1 2 3 )
%
```

```
 SET TITLE
 'Short term resp for HEAVE, short crested sea'  ' '  ' '  ' '
 DISPLAY SHORT-TERM-RESPONSE  ( 7 8 9 )
%
 SET TITLE
 'Short term resp for PITCH, long crested sea'  ' '  ' '  ' '
 DISPLAY SHORT-TERM-RESPONSE  ( 4 5 6 )
%
 SET TITLE
 'Short term resp for PITCH, short crested sea'  ' '  ' '  ' '
 DISPLAY SHORT-TERM-RESPONSE ( 10 11 12 )
%
 SET TITLE
 'Long term response for HEAVE'  ' '  ' '  ' '
 DISPLAY LONG-TERM-RESPONSE RESPONSE-VARIABLE HEAVE LOG (0 45 90)
 DISPLAY LONG-TERM-RESPONSE RESPONSE-VARIABLE HEAVE WAVE-DIR 6
%
 SET TITLE
 'Long term response for PITCH'  ' '  ' '  ' '
 DISPLAY LONG-TERM-RESPONSE RESPONSE-VARIABLE PITCH LOG (0 45 90)
 DISPLAY LONG-TERM-RESPONSE RESPONSE-VARIABLE PITCH WAVE-DIR 6
%
%    Exit from Postresp
%
  FILE EXIT
```

Wave spreading used for short crested sea
Wave Spreading function: COS2, Cos**2

Transfer function for first order motion
Amplitude of Response Variable

SESAM POSTRESP 6.1-01   26 NOV 1993

Transfer function for first order motion
Amplitude of Response Variable

Angular Frequency (rad/s)

Amplitude

PITCH Dir=0.0
PITCH Dir=45.0
PITCH Dir=90.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Transfer function for first order motion
Amplitude of Response Variable

Legend:
- △ ADISZSP   Dir=0.0
- + ADISZSP   Dir=45.0
- □ ADISZSP   Dir=90.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Transfer function for first order motion
Amplitude of Response Variable

Transfer function for first order motion
Amplitude of Response Variable

SESAM POSTRESP 6.1-01   26 NOV 1993

Transfer function for first order motion
Amplitude of Response Variable

Wave period (seconds)

HEAVE   Dir=0.0
HEAVE   Dir=45.0
HEAVE   Dir=90.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Transfer function for first order motion
Amplitude of Response Variable

Wave period (seconds)

-△- PITCH   Dir=0.0
-+- PITCH   Dir=45.0
.□. PITCH   Dir=90.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Response spectra for HEAVE, short crested sea
Response Spectrum

Energy density ((l**2)*s)

Angular Frequency (rad/s)

△ 7:	HEAVE Dir=0.0 FRPM11 COS2	
+ 8:	HEAVE Dir=45.0 FRPM11 COS2	
□ 9:	HEAVE Dir=90.0 FRPM11 COS2	

Identical parameters
Depth   250.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Response spectra for PITCH, short crested sea
Response Spectrum

Energy density ((l**2)*s)

Angular Frequency (rad/s)

⌂ 10:	PITCH	Dir=0.0	FRPM11	COS2
+ 11:	PITCH	Dir=45.0	FRPM11	COS2
□ 12:	PITCH	Dir=90.0	FRPM11	COS2

Identical parameters
Depth   250.0

SESAM POSTRESP 6.1-01   26 NOV 1993

Short term resp for HEAVE, long crested sea
Short Term Response

Energy density ((m**2)*s)

Zero upcrossing period (s)

```
 ⌂  1:  HEAVE   Dir=0.0    FRPM1-FRPM21
 +  2:  HEAVE   Dir=45.0   FRPM1-FRPM21
 ⊡  3:  HEAVE   Dir=90.0   FRPM1-FRPM21
```

SESAM POSTRESP 6.1-01   26 NOV 1993

Short term resp for PITCH, long crested sea
Short Term Response

Energy density ((t**2)*s))

Zero upcrossing period (s)

△ 4:	PITCH	Dir=0.0	FRPM1-FRPM21
+ 5:	PITCH	Dir=45.0	FRPM1-FRPM21
□ 6:	PITCH	Dir=90.0	FRPM1-FRPM21

SESAM POSTRESP 6.1-01   26 NOV 1993

Short term resp for PITCH, short crested sea
Short Term Response

Energy density (((**2)*s))

Zero upcrossing period (s)

	10:	PITCH	Dir=0.0	FRPM1-FRPM21	COS2
	11:	PITCH	Dir=45.0	FRPM1-FRPM21	COS2
	12:	PITCH	Dir=90.0	FRPM1-FRPM21	COS2

SESAM POSTRESP 6.1-01   26 NOV 1993

Long term response for HEAVE
Long Term Response

Response Variable
△ HEAVE Dir=0.0
+ HEAVE Dir=45.0
□ HEAVE Dir=90.0
▽ HEAVE All Inc.

SESAM POSTRESP 6.1-01   26 NOV 1993

Long term response for PITCH
Long Term Response
Probability level: 6.0000

Response Variable
△ PITCH

Wave Direction

APPENDIX B   THEORY AND FORMULATION

B 1   SHORT TERM DESCRIPTION OF SEA

In a short term description of the sea, the statistical properties of the waves are treated as being invariant over a period lasting a few hours. The sea surface is regarded as the sum of an infinite number of elementary sinusoidal waves with different frequencies and directions and with random phase angles. The distribution of wave energy according to the frequencies of the wave components is represented by a wave spectrum.

B 1.1   Wave Energy Spreading Function

Short-crested waves are the combination of different long-crested waves from different directions. The wave energy of such a system may be described by a directional wave spectrum $S(\omega, \alpha)$ of the form

$$S(\omega, \alpha) = S(\omega)f(\alpha) \tag{B.1}$$

where $S(\omega)$ is the unidirectional wave spectrum with energy distributed according to wave frequency ω.

The function $f(\alpha)$ represents the directional distribution of energy in the waves and is defined in the following way

$$f(\alpha) = \frac{\displaystyle\int_{\alpha - \delta/2}^{\alpha + \delta/2} \cos^n x\, dx}{\displaystyle\int_{-\pi/2}^{\pi/2} \cos^n x\, dx} \tag{B.2}$$

where α represents the angle of the elementary waves relative to the main direction β of the short-crested wave system, and δ is the wave direction spacing. See Figure B.1.

The larger the value of n, the more sharp is the distribution function and the more concentrated is the directional energy distribution.

Furthermore the denominator of Equation (B.2) is to satisfy the requirement

$$\int_{-\pi/2}^{\pi/2} f(\alpha)d\alpha = 1 \tag{B.3}$$

The cosine-*n* directional distribution is then

$$f(\alpha) = \begin{cases} \dfrac{\displaystyle\int_{\alpha-\delta/2}^{\alpha+\delta/2} \cos^n x\,dx}{\displaystyle\int_{-\pi/2}^{\pi/2} \cos^n x\,dx} & -\pi/2 \leq \alpha \leq \pi/2 \\[20pt] 0 & \text{otherwise} \end{cases} \tag{B.4}$$
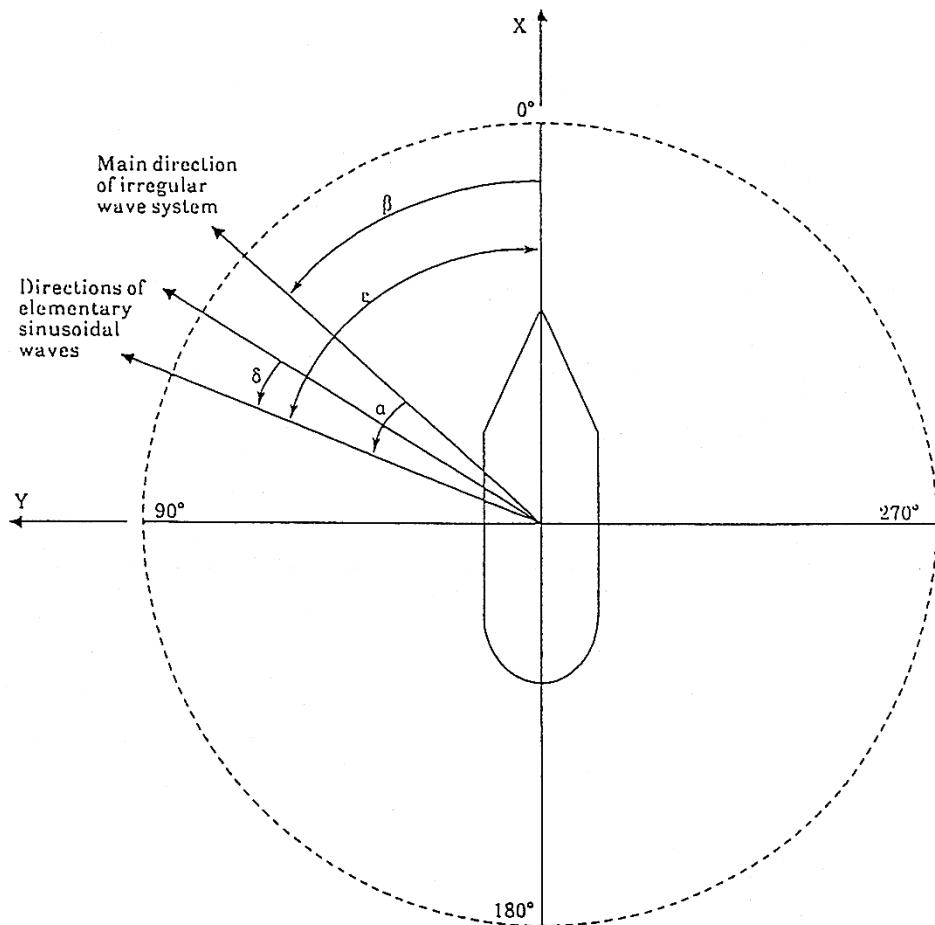
Figure B.1   Definition of heading angles between ship and waves

B 1.2   Pierson-Moskowitz Spectrum

The Pierson-Moskowitz spectrum may be written as

$$S(\omega) = \alpha g^2 \omega^{-5} e^{\frac{-5}{4}\left(\frac{\omega}{\omega_p}\right)^{-4}} \tag{B.5}$$

where α is a slope parameter (set equal to 0.0081, Phillip's Constant), g is the acceleration due to gravity, and ω_p is the frequency corresponding to the peak of the spectrum ($\omega_p = 2\pi/T_p$).

A more convenient form of the Pierson-Moskowitz spectrum has been developed in terms of the seastate parameters H_s and T_z and is referred to as the Modified-Pierson-Moskowitz spectrum. This form is of more direct use for engineering purposes and may be written as

$$S(\omega) = \frac{H_s^2 T_z}{8\pi^2}\left(\frac{\omega T_z}{2\pi}\right)^{-5} e^{\frac{-1}{\pi}\left(\frac{\omega T_z}{2\pi}\right)^{-4}} \tag{B.6}$$

The significant wave height H_s is determined from the zero order moment m_0 of the wave spectrum

$$H_s = 4\sqrt{m_0} \tag{B.7}$$

The mean zero-up-crossing period is determined from the zero order moment m_0 and the second order moment m_2 of the wave spectrum

$$T_z = 2\pi\sqrt{m_0/m_2} \tag{B.8}$$

B 1.3   JONSWAP Spectrum

The Jonswap spectrum can be described as a function of the four parameters (α, ω_p, γ, σ) or alternatively by the four parameters (H_s, T_z, γ, σ).

In the first form the spectrum can be written as

$$S(\omega, \alpha, \omega_p, \gamma, \sigma) = \alpha g^2 \omega^{-5} \exp\left(\frac{-5}{4}\left(\frac{\omega}{\omega_p}\right)^{-4}\right)\gamma^a \tag{B.9}$$

where

$$a = \exp\left(\frac{-1}{2}\left(\frac{\omega - \omega_p}{\sigma\omega_p}\right)^2\right) \tag{B.10}$$

We now want to establish a relation between (α, ω_p) and (H_s, T_z). We do this by computing m_0 and m_2. From the spectrum definition above we see that the moments can be written as

$$m_0 = \alpha g^2 \omega_p^{-4} F_0(\gamma, \sigma) \tag{B.11}$$

$$m_2 = \alpha g^2 \omega_p^{-2} F_2(\gamma, \sigma) \tag{B.12}$$

Now we can easily compute Hs and T z as

$$H_s(\alpha, \omega_p) = 4\sqrt{m_0} = 4g\omega_p^{-2}\sqrt{\alpha F_0(\gamma, \sigma)} \tag{B.13}$$

$$T_z(\alpha, \omega_p) = 2\pi\sqrt{m_0/m_2} = 2\pi\omega_p^{-1}\sqrt{F_0/F_2} = T_p\sqrt{F_0/F_2} \tag{B.14}$$

and the inverse relations as

$$\alpha(H_S, T_z) = \left(\frac{F_0}{F_2^2}\right)\left(\frac{H_s\pi^2}{gT_z^2}\right)^2 \tag{B.15}$$

$$\omega_p(H_S, T_z) = 2\pi\omega T_z^{-1}\sqrt{F_0/F_2} \tag{B.16}$$

B 1.4   Gamma Spectrum

The Gamma spectrum may be written as

$$S(\omega) = A\omega^{-l}e^{-B\omega^{-n}} \tag{B.17}$$

where A, B, l and n are parameters of the spectrum. The parameter A is a scale parameter of the wave frequency ω. The parameter B determines the overall level of the spectral density and thus indicates the general severity of the seastate. The third parameter l, determines the asymptotic behaviour of the high frequency tail of the spectrum, and the fourth parameter n, influences the low frequency flank and also the sharpness of the peak. The parameters A and B may be expressed in terms of the seastate parameters H_s and T_z, i.e.

$$A = \frac{H_s^2 n}{16}\left(\frac{2\pi}{T_z}\right)^{l-1} \frac{\Gamma(\frac{l-1}{n})^{\frac{l-3}{2}}}{\Gamma(\frac{l-3}{n})^{\frac{l-1}{2}}} \tag{B.18}$$

$$B = \left(\frac{2\pi}{T_z}\right)^n \frac{\Gamma(\frac{l-1}{n})^{\frac{n}{2}}}{\Gamma(\frac{l-3}{n})^{\frac{n}{2}}} \tag{B.19}$$

where $\Gamma(\ )$ denotes the gamma function.

The Pierson-Moskowitz spectrum is a special case of the Gamma spectrum, with parameters $l = 5$ and $m = 4$.

B 1.5   ISSC Spectrum

The ISSC (International Ship and Offshore Structure Congress) spectrum may be written as

$$S(\omega) = H_s^2 \frac{A}{4\omega_1} \left(\frac{\omega}{\omega_1}\right)^{-5} e^{-A\left(\frac{\omega}{\omega_1}\right)^{-4}} \tag{B.20}$$

where H_s is the significant wave height and ω_1 is the mean wave frequency which is related to the mean wave period T_1 by

$$\omega_1 = \frac{2\pi}{T_1} \tag{B.21}$$

The mean wave period T_1 is defined by

$$T_1 = 2\pi \frac{m_0}{m_1} \tag{B.22}$$

The mean wave period T_1 is related to the mean zero up-crossing period T_1 by

$$\frac{T_1}{T_z} = \frac{\sqrt{m_0 m_2}}{m_1} = \frac{\sqrt{\Gamma\left(\frac{1}{2}\right)}}{\Gamma\left(\frac{3}{4}\right)} = \frac{\sqrt[4]{\pi}}{\Gamma\left(\frac{3}{4}\right)} = \frac{\sqrt[4]{\pi}}{\pi\sqrt{2}}\Gamma\left(\frac{1}{4}\right) = 1.086435 \tag{B.23}$$

The parameter A may be written as

$$A = \frac{1}{\pi}\left(\frac{T_1}{T_z}\right)^4 = \left(\Gamma\left(\frac{3}{4}\right)\right)^{-4} = 0.44347 \tag{B.24}$$

B 1.6   Ochi-Hubble Spectrum

The six parameter Ochi-Hubble spectrum consists of essentially two parts; one for the lower frequency components of the wave energy and the other covering the higher frequency components. Each component is expressed in terms of three parameters and the total spectrum is written as a linear combination of the two. Thus, double peaks present in a wave energy density can be modelled with this formulation, e.g. a low-frequency swell along with the high-frequency wind generated waves.

The spectrum may be expressed by

$$S_\eta(\omega) = \frac{1}{4} \sum_{j=1}^{2} \frac{(\tilde{\lambda}_j \omega_{0j}^4)^{\lambda_j}}{\Gamma(\lambda_j)} \frac{H_{sj}^2}{\omega^{4\lambda_j + 1}} \exp\left(-\tilde{\lambda}_j\left(\frac{\omega}{\omega_{0j}}\right)^{-4}\right) \tag{B.25}$$

where

$$\tilde{\lambda}_j = \frac{4\lambda_j + 1}{4} \tag{B.26}$$

and where index $j = 1$ corresponds to the lower frequency components and $j = 2$ to the higher frequency components. H_{sj}, ω_{0j}, λ_j are significant wave height, modal frequency of the spectral peak and shape factor of component j, respectively. The spectrum is illustrated in Figure B.3.

If in either spectral component the values of the parameters H_{sj} and ω_{0j} are held constant, λ_j controls the shape, or, in particular the sharpness of the spectral peak. Thus, λ_j is called the spectral shape parameter. If $\lambda_1 = 1$ and $\lambda_2 = 0$, we obtain the Pierson-Moskowitz spectrum model. In the general formulation of Equation (B.25), the equivalent significant height H_s is obtained from

$$H_s = \sqrt{H_{s1}^2 + H_{s2}^2} \tag{B.27}$$

on the assumption of narrowbandedness of the entire spectrum. Generally, the value of λ_1 is much higher than that of λ_2.
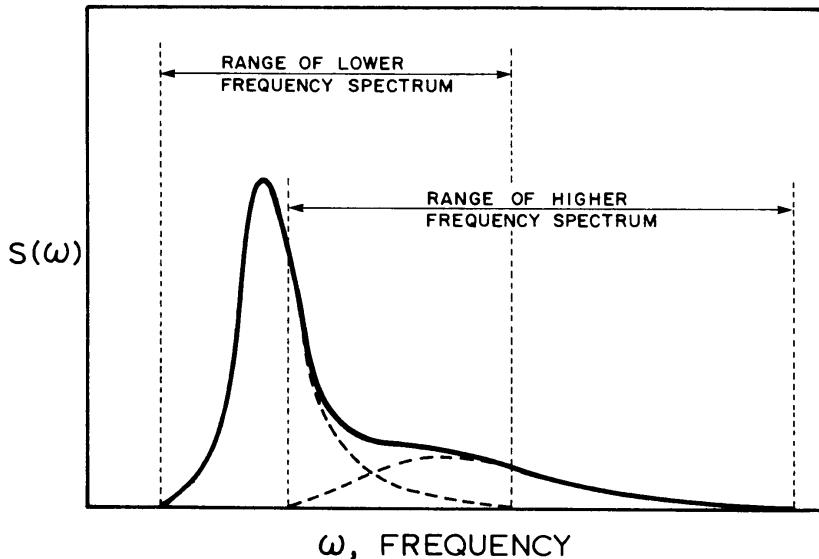
Figure B.3   Ochi-Hubble double peaks spectrum model

B 1.7   Torsethaugen Spectrum

The sea state is described by superposing a part according to locally wind generated sea on another part according to swell. Each of the parts is described by a generalized Jonswap spectrum. The generalized Jonswap spectrum S, as a function of the orbital frequency ω has the form:

$$S(\omega) = G0\,\omega^{-N} e^{-\frac{N}{M}\left(\frac{\omega}{w_p}\right)^{-M}} \gamma^a \tag{B.28}$$

where γ denotes the peak-enhancement factor with exponent a defined by.

$$a = e^{-\frac{1}{2}\left(\frac{\omega - \omega_p}{\sigma\omega_p}\right)^2} \tag{B.29}$$

The parameter σ is a measure of the width of the spectral peak, here put equal to 0.07 if $\omega \le \omega_p$ and 0.09 if $\omega > \omega_p$. is the orbital frequency of the peak, related to the peak period T_p by $\omega = 2\pi / T_p$. $G0$ is a "normalizing factor for the Pierson-Moskowitz form" and is given by:

$$G0 = \frac{M\left(\frac{N}{M}\right)^{\frac{N-1}{M}}}{\Gamma(\frac{N-1}{M})} h \tag{B.30}$$

Γ denotes the complete gamma function. h is a factor used to fit the spectrum to a given significant wave-height H_s. In other words:

$$h = H_s\left(\int_0^\infty \frac{M\left(\frac{N}{M}\right)^{\frac{N-1}{M}}}{\Gamma(\frac{N-1}{M})} \omega^{-N} e^{-\frac{N}{M}\left(\frac{\omega}{\omega_p}\right)^{-M}} \gamma^a d\omega\right)^{-1} \tag{B.31}$$

The ordinary Jonswap spectrum is obtained by putting M=4 and N=5. If, in addition $\gamma=1$, we have the Pierson-Moskowitz (PM) spectrum. In many descriptions of Jonswap and PM spectra, H_s is assumed given by Phillips' constant α, so that $h = \alpha \cdot g^2$, where g is the acceleration due to gravity.

H_s, T_p, M, N and γ are dependent of a set of semi-empiric parameters. The functional relations are different for the swell part and the wind part and are different according to whether the total sea state is regarded as wind-dominated or swell-dominated.

B 1.7.1   Basic Constants

The following set of constants is basic to all the others:

$$AF = 6.6$$
$$AE = 2.0$$
$$AU = 25.0$$
$$A10 = 0.7$$
$$A1 = 0.5$$
$$KG = 35.0$$
$$KG0 = 3.5$$
$$KG1 = 1.0$$
$$R = 0.857$$
$$K0 = 0.5$$
$$K00 = 3.2$$
$$M0 = 4.0$$
$$B1 = 2.0$$
$$A20 = 0.6$$
$$A2 = 0.3$$
$$A3 = 6.0$$
$$S0 = 0.08$$
$$S1 = 3.0$$
$$B2 = 0.7$$
$$B3 = 3.0$$

B 1.7.2   Definition of sea state type

The seastate is defined as wind dominated or swell dominated according to whether the primary peak period is below or above a value *TF* given by:

$$TF = AF \cdot Hs^{\frac{1}{3}} \tag{B.32}$$

Based on this, lower and upper period fractions are defined:

$$\varepsilon_L = \frac{TF - TP}{TF - AE\sqrt{Hs}}, \quad \varepsilon_U = \frac{TF - TP}{TF - AU} \tag{B.33}$$

B 1.7.3   Wind dominated sea

Primary peak

Significant wave height:

$$Hs_p = Hs \cdot \left[(1 - A10) \cdot e^{-\left(\frac{\varepsilon_L}{A1}\right)^2} + A10 \right] \tag{B.34}$$

Spectral period:

$$Tpp = Tp \tag{B.35}$$

Peak enhancement factor:

$$\gamma_p = KG \cdot (1 + KG0 \cdot e^{\frac{-Hs}{KG1}}) \cdot (\frac{2\pi \cdot Hs}{g \cdot Tp^2})^R \tag{B.36}$$

High frequency exponent:

$$N_p = K0\sqrt{Hs} + K00 \tag{B.37}$$

Spectral width exponent:

$$M_p = M0 \tag{B.38}$$

Secondary peak

Significant wave height:

$$\tag{B.39}$$

$$Hs_s = Hs \cdot \sqrt{1 - \left[(1 - A10) \cdot e^{-\left(\frac{\varepsilon_L}{A1}\right)^2} + A10 \right]^2}$$

Spectral period:

$$(B.40)$$

$$Tps = TF + B1$$

Peak enhancement factor:

$$(B.41)$$

$$\gamma_s = 1$$

High frequency exponent:

$$(B.42)$$

$$N_s = N_p$$

Spectral width exponent:

$$(B.43)$$

$$M_s = M_p$$

B 1.7.4   Swell dominated sea

Primary peak

Significant wave height:

$$(B.44)$$

$$Hs_p = Hs \cdot \left[(1 - A20) \cdot e^{-(\frac{\varepsilon_U}{A2})^2} + A20 \right]$$

Spectral period:

(B.45)

$$Tpp = Tp$$

Peak enhancement factor:

(B.46)

$$\gamma_p = (1 + A3 \cdot \varepsilon_U) \cdot KG \cdot (1 + KG0 \cdot e^{\frac{-Hs}{KG1}}) \cdot (\frac{2\pi \cdot Hs}{g \cdot TF^2})^R$$

High frequency exponent:

(B.47)

$$N_p = K0\sqrt{Hs} + K00$$

Spectral width exponent:

(B.48)

$$M_p = M0$$

Secondary peak

Significant wave height:

(B.49)

$$Hs_s = Hs \cdot \sqrt{1 - \left[(1 - A20) \cdot e^{-(\frac{\varepsilon_U}{A2})^2} + A20 \right]^2}$$

Spectral period:

(B.50)

$$Tps = \frac{16 \cdot S0 \cdot (1 - e^{-\frac{Hs}{S1}}) \cdot (0.4^{Ns})}{(G0 \cdot Hs_s^{\,2})^{\frac{-1}{Ns-1}}}$$

Peak enhancement factor:

(B.51)

$$\gamma_s = 1$$

High frequency exponent:

(B.52)

$$N_s = N_p$$

Spectral width exponent:

(B.53)

$$M_s = M0 \cdot (1 - B2 \cdot e^{-\frac{Hs}{B3}})$$

B 1.7.5   The combined spectrum for wind and swell

Thus the total doubly peaked spectrum is the sum of the generalized Jonswap spectrum for the primary peak and the generalized Jonswap spectrum for the secondary peak, each dependent on the parameters Hs_p, Tp_p, M_p, N_p and γ_s or Hs_s, Tp_s, M_s, N_s and γ_s. These constants are in turn functions of the basic parameters Hs and Tp for the total spectrum. Hs is the significant wave height of the total spectrum, whereas Tp is taken as the period of the primary peak. In other words the total doubly peaked spectrum $S_{dps}(\omega)$ is constructed as:

$$(B.54)$$

$$
\begin{aligned}
s_{dps}(\omega) \;=\;& s(\omega;\; Hs = Hs_p;\; Tp = TP_p;\; N = N_p;\; M = M_p;\; \gamma = \gamma_p) \\
+\;& s(\omega;\; Hs = Hs_s;\; Tp = TP_s;\; N = N_s;\; M = M_s;\; \gamma = \gamma_s)
\end{aligned}
$$

B 2   LONG TERM DESCRIPTION OF SEA

Long term statistics are associated with non-stationary processes occurring over periods of months and years, whereas short term statistics, covered in the previous section, relate to stationary processes in periods lasting only a few hours. In forming a long term statistical description of the seas, a suitable statistical model providing a joint probability distribution of wave height and wave period is required.

B 2.1   Statistical Model

The statistical model of the wave data provides the joint probability of occurrence $f(H_s, T_z)$ of significant wave height and the mean zero-up-crossing period. In Postresp, this joint probability is formulated as the product of the probability of wave period and the probability of wave height within that wave period, Ref. /1/.

$$f(H_s, T_s) \;=\; f(T_z)f(H_s|T_z) \tag{B.55}$$

where the parameters of the wave height distribution for one specific value of wave period are determined independently of the parameters for other wave periods (conditional distribution).

B 2.2   Distribution of Wave Height

A three-parameter Weibull distribution may be employed to describe the distribution of wave height for each wave period

$$f(H_s) \;=\; 1 - e^{-\left(\frac{H_s - H_0}{H_c - H_0}\right)^m} \tag{B.56}$$

where $f(H_s)$ is the probability that the significant wave height does not exceed H_s. The parameters H_0, H_c, H_0 and m describe the threshold, scale, and slope of the distribution respectively.

B 2.3   Transformation Parameters

The given Weibull distribution function is written in a form suitable for direct application to instrumental data. However much of the data available is based on visual observations of wave height H_v and wave period T_v. Relationships have been developed, Ref. /1/, to transform the visual data to equivalent instrumental values.

The relationship between wave heights is given in form

$$H_s = A_H H_v^{B_H} \tag{B.57}$$

This relationship has been determined such that the probability to exceed H_v equals the probability to exceed H_s. Recommended values of the transformation parameters for wave heights are $A_H = 1.68$ and $B_H = 0.75$.

Similarly, the relationship for wave periods is given in the form

$$T_z = A_T T_v^{B_T} \tag{B.58}$$

Recommended values of the transformation parameters for wave periods are $A_T = 2.83$ and $B_T = 0.44$.

Parameters of the Weibull distributions of visual wave height for the North Atlantic and North Sea are given in table B.1 and table B.2.

Parameters of the Weibull distributions of visual wave height at weather stations A, B, C, D, E, I, J, K and M on the North Atlantic (T_v in secs, H_0 and H_c in meters, Ref. /1/).

Table B.1

T_v	$f(H_v)$	H_0	H_c-H_0	m
4.5	0.1190	1.0	0.25	0.63
6.5	0.3455	1.25	0.95	0.85
8.5	0.3586	1.10	2.05	1.13
10.5	0.1385	0.75	3.30	1.56
12.5	0.0291	0.35	5.00	1.82
14.5	0.0056	0.20	6.15	2.02
16.5	0.0010	0.00	6.30	1.86
18.5	0.0028	0.35	2.00	0.85

Parameters of the Weibull distributions of visual wave heights on the North Sea (T_v in secs, H_0 and H_c in meters, Ref. /1/).

Table B.2

T_v	$f(H_s)$	H_0	H_c-H_0	m
3.0	0.0335	0	0.72	3.06
4.0	0.0496	0	0.89	2.27
5.0	0.1517	0	0.80	1.15
6.0	0.4319	0	1.25	1.54

Table B.2

7.0	0.1785	0	2.03	2.27
8.0	0.1415	0	2.40	2.63
9.0	0.0100	0	2.40	2.17
10.0	0.0033	0	2.95	2.90

B 3   TRANSFER FUNCTIONS

B 3.1   Basic Transfer Functions

A transfer function describes the response of a structure in regular sinusoidal waves over a range of frequencies. The amplitude of the response is normalized with respect to the amplitude of the wave. A representation in the complex plane is used in order to carry phase information between the response variable and the incoming wave.

Once the complex transfer function H_x for response variable x is known, the time dependent response variable can be determined form

$$R(t) = \xi_a \cdot \text{Re}[H_x e^{i\omega x}] \tag{B.59}$$

where ξ_a is the amplitude of the incoming wave, ω is the frequency of the incoming wave, and t denotes the time.

In terms of phase angle and amplitude this is:

$$R(t) = \xi_a \cdot |H_x| \cdot \cos(\omega t + \phi) \tag{B.60}$$

The phase angle ϕ of the response with respect to the incoming wave and amplitude $|H|$ is then given by

$$\phi = arc\tan\frac{H^I}{H^R}, \qquad |H| = \sqrt{(H^R)^2 + (H^I)^2} \tag{B.61}$$

where H^R and H^I are the real and imaginary parts of the transfer function respectively.

The response top then occurs $\Delta t = \phi / \omega$ **before** the wave crest at origin (phase lead).

B 3.2   Standard Combinations

Transfer functions may be combined to describe other responses. The complex transfer functions of the basic motions in the six degrees of freedom, for example, may be combined to describe other motions in the x, y and z directions, at arbitrary locations on the structure. Some examples that illustrate the combination process are provided below.

The absolute motion in the z direction is given by

$$H_{AM(z)} = H_{heave} - xH_{pitch} + yH_{roll}$$ (B.62)

The relative motion in the z direction is given by

$$H_{RM(z)} = H_{AM(z)} - H_{wave(z)}$$ (B.63)

The absolute motion in the y direction is given by

$$H_{AM(y)} = H_{sway} + xH_{yaw} - zH_{roll}$$ (B.64)

The absolute motion in the x direction is given by

$$H_{AM(x)} = H_{surge} - yH_{yaw} + zH_{pitch}$$ (B.65)

Transfer functions for the velocity H_V, and the acceleration H_A may be derived from the motion transfer functions H_M using the relationships

$$H_V = i\omega H_M$$ (B.66)

$$H_A = -\omega^2 H_M$$ (B.67)

B 3.3   Special Combinations

Special combinations of transfer functions H_{SC} may also be derived

$$H_{SC} = \sum_{i=1}^{i=n} C_{xi}H_{xi} \qquad i = 1\ldots n$$ (B.68)

where C_x is a constant factor for each response variable x_i involved in the combination of the transfer functions H_x.

B 4   SHORT TERM RESPONSE

The responses of a structure to an irregular short-crested stationary seastate, may be calculated from a wave energy spectrum and the transfer functions of the various responses by means of the linear superposition technique.

B 4.1   Spectral Moments

The cth order spectral moment M_c is given by

$$M_c = \int_{-\pi/2}^{\pi/2} \int_0^\infty \omega^c |H_x(\omega,\varepsilon)|^2 S(\omega)f(\alpha)d\omega d\alpha \tag{B.69}$$

The significant response X_s (double amplitude) for the response variable x, is defined as the mean of the one-third largest responses in the response spectrum. This is related to the zero moment M_0 by

$$X_s = 4\sqrt{M_0} \tag{B.70}$$

The mean zero-up-crossing period T_x of the response is related to the zero order and the second order moments of the response spectrum and is given by

$$T_x = 2\pi\sqrt{M_0/M_2} \tag{B.71}$$

B 4.2 Response Variance

The variance $(\sigma_x)^2$ of the response due to short-crested waves is given by

$$\sigma_x^2(\beta) = \int_{-\pi/2}^{\pi/2} \int_0^\infty |H_x(\omega, \varepsilon)|^2 S(\omega)f(\alpha)d\omega d\alpha = M_0 \tag{B.72}$$

where β is the heading angle between the direction of the main wave system and the ship, $\varepsilon = \beta+\alpha$, is the heading angle between the elementary sinusoidal waves and the ship, and α is the angle of the elementary waves relative to the main direction of the irregular wave system. See Figure B.1.

The individual response spectra are defined by

$$S_R(\omega, \varepsilon) = |H_x(\omega, \varepsilon)|^2 S(\omega)d(\omega) \tag{B.73}$$

while the compound response spectra are defined by

$$S_{RC}(\omega) = \int_{-\pi/2}^{\pi/2} S_R(\omega, \varepsilon)f(\alpha)d\alpha \tag{B.74}$$

When creating each individual response spectrum, using a JONSWAP, Pierson-Moskowitz or user-defined spectrum, the transfer function selected is divided linearly without any smoothing in 201 frequencies corresponding to which the wave spectrum is given. The numerical integration for calculating the spectral parameters is then performed in these 201 points with normal trapeze integration within the frequency range for which the transfer function and wave spectrum is given. No extrapolation or asymptotic approaches are used.

Using a general gamma spectrum, the response spectrum itself is not calculated, only the spectral parameters are calculated analytically.

B 4.3 Response Covariance

The covariance is a measure of the degree of inter-relationship between responses. Considering the response variables x_1 and x_2, the covariance, Cov (x_1, x_2) is given by

$$Cov(x_1, x_2) = 1/2 \int_{-\pi/2}^{\pi/2} \int_{-\infty}^{\infty} H_{x_1}(\omega, \varepsilon) H_{x_2}^*(\omega, \varepsilon) S(\omega) f(\alpha) d\omega d\alpha \tag{B.75}$$

where H^* denotes the complex conjugate of the complex transfer function H.

The normalized covariance or correlation coefficient is defined as

$$\rho = \frac{Cov(x_1, x_2)}{\sigma_{x_1} \sigma_{x_2}} \tag{B.76}$$

where σ_{x1} and σ_{x2} are the standard deviation values of the individual response variables x_1 and x_2.

If ρ is large and positive (i.e. approaching +1) the values of the two response components tend to be both large or small at the same time, whereas if ρ is large and negative (i.e. approaching -1) the value of one response component tends to be large when the other is small. If ρ is small or zero there tends to be little or no relationship between the two response components.

B 4.4 Response Maxima

The distribution of response maxima in a short term seastate is described using the Rice distribution function

$$F_s(x) = \Phi\left(\frac{x}{\varepsilon \sigma_x}\right) - \sqrt{1-\varepsilon^2} \Phi\left(\frac{\sqrt{1-\varepsilon^2}}{\varepsilon} \frac{x}{\sigma_x}\right) e^{\frac{-1}{2}\left(\frac{x}{\sigma_x}\right)^2} \tag{B.77}$$

where $\Phi()$ is the normal probability integral, σ_x is the standard deviation of the response, and ε is the spectral width parameter given by

$$\varepsilon = \left[1 - \frac{M_2^2}{M_0 M_4}\right]^{\frac{1}{2}} \tag{B.78}$$

In the case of $\varepsilon = 0$ the general Rice distribution reduces to the Rayleigh distribution

$$F_s(x) = 1 - e^{-\left(\frac{x^2}{2\sigma_x^2}\right)} \tag{B.79}$$

The most probable largest response X_{max} occurring within a time interval of N_c response maxima is approximately given by

$$X_{max} = \sqrt{2}\sigma_x[\ln(\sqrt{1-\varepsilon^2}N_c)]^{1/2} \tag{B.80}$$

In the case of a narrow banded spectrum, i.e. $\varepsilon = 0$, the most probable largest response is given by

$$X_{max} = \sqrt{2}\sigma_x\sqrt{\ln N_s} \tag{B.81}$$

where N_s represents the number of zero-upcrossings in the short term sea state. Under narrow band conditions the number of zero-upcrossings N_s equals the number of response maxima N_c.

The number of zero-upcrossings N_s may be determined from the duration of the short term seastate D_s and the mean-zero-upcrossing response period T_x i.e.

$$N_s = \frac{D_s}{T_x} \tag{B.82}$$

When viewed within extreme value statistics, "the most probable largest" value has a 63% chance of being exceeded, i.e. out of a large number of identical floating structures present in the same ocean area, 63% will experience a higher maximum value than the most probable largest.

B 5   LONG TERM RESPONSE

In Postresp the long term marginal distribution of response is derived using the short term (Rayleigh) distributions $F_s(x \mid H_s,T_z)$ of response maxima, the short term mean zero-up-crossing period of the response T_x (H_s,T_z), and the joint probability density of the wave parameters $f(H_s,T_z)$, Ref. /2/.

The joint probability density may be based on a statistical model of wave data or taken directly from a wave scatter diagram. However in connection with extreme response prediction, the use of a statistical model is preferred since it provides a means of including the steep infrequent seastates that may in some cases be absent from a wave scatter diagram based on observations of limited duration.

B 5.1   Derivation of Long Term Distribution

It is required to determine the long term marginal distribution $F_L(x)$ for response variable x. The total duration to be considered is denoted D_L.

The (infinitesimal) duration of any sea state may be expressed by

$$D_s(H_s,T_z) = D_L f(H_s,T_z)dH_s dT_z \tag{B.83}$$

The expected number of response maxima in the sea state is given by the duration of the sea state divided by the mean response period

$$N_s = (H_s, T_z) = \frac{D_s(H_s, T_s)}{T_x(H_s, T_z)} = \frac{D_L f(H_s, Tz) dH_s dT_z}{T_x(H_s, T_z)} \tag{B.84}$$

The number of response maxima not exceeding the level x is obtained from the product of the expected number of response maxima in the sea state, and the cumulative probability

$$N_s(x;H_s,T_z) = N_s(H_s,T_z)F_s(x|H_s,T_z) = \frac{D_L f(H_s,T_z)F_s(x|H_s,T_z)}{T_x(H_s,T_z)} dH_s dT_w \tag{B.85}$$

The number of response cycles not exceeding the level x in the long term is obtained by integrating the short term result over the range of sea states that may be experienced

$$N_L(x) = D_L \iint \frac{f(H_s,T_z)F_s(x|H_s,T_z)}{T_x(H_s,T_z)} dH_s dT_z \tag{B.86}$$

Finally, the long term probability of not exceeding the level x is given by dividing the number of response maxima that do not exceed this level by the total number of response maxima

$$F_L(x) = \frac{N(x)}{N(\infty)} = T_{xL} \iint \frac{f(H_s, T_z)F_s(x|H_s, T_z)}{T_x(H_s, T_z)} dH_s dT_z \tag{B.87}$$

where the total number of response maxima, are simply the number of response maxima which is never exceeded $N(\infty)$, and the long term mean response period is obtained by dividing the long term duration by the total number of response cycles

$$T_{xL} = \frac{D_L}{N(\infty)} = \left[\iint \frac{f(H_s,T_z)}{T_x(H_s,T_z)} dH_s dT_z \right]^{-1} \tag{B.88}$$

A Weibull distribution may then be fitted to the numerical long term response distribution

$$F_L(x) = 1 - e^{-\left(\frac{x}{a}\right)^m} \tag{B.89}$$

where α is referred to as the scale parameter of the distribution, and *m* is referred to as the slope parameter of the distribution.

The probability of exceeding the response level x is given by

$$Q(x) = 1 - F_L(x) \tag{B.90}$$

The response prediction provided by the statistical model above relates to the "most probable largest" value and when viewed within extreme value statistics, this value has a 63% chance of being exceeded.

B 6   Theoretical Background for Second Order Statistics

B 6.1   Introduction

The output $x(t)$ of a second order Volterra system to input $\eta(t)$ is given in terms of the first and second order transfer functions by:

$$
x(t) = \mathrm{Re} \sum_{k=1}^{N} a_k e^{i(\omega_k t + \theta_k)} H_1(\omega_k)
$$

$$
+ q\,\mathrm{Re} \sum_{k=1}^{N} \sum_{l=1}^{N} [a_k a_l e^{i[(\omega_k - \omega_l)t + \theta_k - \theta_l]} H_{2\text{-}}(\omega_k, \omega_l) + a_k a_l e^{i[(\omega_{kk} + \omega_l)t + \theta_k + \theta_l]} H_{2\text{+}}(\omega_k, \omega_l)]
$$

(B.91)

where a_k and θ_k are the Fourier amplitudes and phases of the input $\eta(t)$ (q will be discussed below). The objective is to calculate the statistical moments of $x(t)$. The stochastic nature of the input η is represented by the fact that a_k and θ_k in Equation (B.91) are random variables. The approach will be to transform the discrete sinusoidal components into uncorrelated standard normal processes. With $x(t)$ written in this way, the moments of $x(t)$ will be more easily computed.

B 6.2   Problem Transformation

The wave elevation $\eta(t)$ is first written as a discrete Fourier sum over positive frequencies ω_k:

$$
\eta(t) = \mathrm{Re} \sum_{k=1}^{N} a_k \cos(\omega_k t + \theta_k)
$$

(B.92)

Equivalently, we may write:

$$
\eta(t) = \mathrm{Re} \sum_{k=1}^{N} a_k e^{i(\omega_k t + \theta_k)}
$$

(B.93)

or:

$$
\eta(t) = \frac{1}{2} \sum_{k=1}^{N} [a_k e^{i(\omega_k t + \theta_k)} + a_k e^{-i(\omega_k t + \theta_k)}]
$$

(B.94)

The stochastic nature of $\eta(t)$ is captured by taking the phases θ_k to be uniformly distributed random variables on the range $[0, 2\pi]$, mutually independent of each other and the amplitudes a_k. To ensure that $\eta(t)$ has a Gaussian distribution for any number of frequencies, the Fourier amplitudes a_k are taken as Rayleigh distributed random variables. The contribution to the total mean square power, $E[\eta^2(t)]$, from frequency ω_k is

then $E[a_k^2\cos^2(\omega_k t+\theta_k)]$, which reduces simply to $E[a_k^2]/2$. Setting this result equal to $S_\eta(\omega_k)\Delta\omega$, in terms of the one-sided power spectrum $S\eta(\omega)$ of $\eta(t)$, we find:

$$E[a_k^2] = 2S_\eta(\omega_k)\Delta\omega \equiv \sigma_k^2 \tag{B.95}$$

Equation (B.95) provides the definition of the one parameter in the Rayleigh distribution for the Fourier wave amplitudes. The total response $x(t)$ of a second order Volterra system to input $\eta(t)$ (equation (G7.1)) can be written as a sum of individual first and second order responses, $x_1(t)$ and $x_2(t)$. The 'response' may in general be a wave force or a structural response quantity. The transformation from wave to response is defined by the first and second order transfer functions $H_1(\omega)$ and $H_2(\omega_1,\omega_2)$. $H_1(\omega)$ is defined by:

$$x_1(t) = \mathrm{Re} \sum_{k=1}^{N} a_k e^{i(\omega_k t + \theta_k)} H_1(\omega_k) \tag{B.96}$$

The sum and difference frequency second order transfer functions, $H_{2+}(\omega_1,\omega_2)$ and $H_{2-}(\omega_1,\omega_2)$, are defined by:

$$x_2(t) = q\mathrm{Re} \sum_{k=1}^{N} \sum_{l=1}^{N} [a_k a_l e^{i[(\omega_k - \omega_l)t + \theta_k - \theta_l]} H_{2-}(\omega_k,\omega_l) + a_k a_l e^{i[(\omega_k + \omega_l)t + \theta_k + \theta_l]} H_{2+}(\omega_k, \omega_l)] \tag{B.97}$$

Introduced in these definitions is the factor q. In the work of Molin and Chen, Ref. /8/, Naess, Ref. /9/, and Marthinsen and Winterstein, Ref. /7/, q is equal to 1/2. In the work of Kim and Yue, Ref. /6/, q is equal to 1. This factor will be carried through the derivations here, allowing the results to be applied to either definition of the second order transfer functions.

Equation (B.97) can be rewritten to make its quadratic form more obvious:

$$x_2(t) = \frac{1}{2} \sum_{k=1}^{N} \sum_{l=1}^{N} [a_k e^{i(\omega_k t + \theta_k)} H_{2-}(\omega_k, \omega_l) a_l e^{-i(\omega_k t + \theta_l)}$$

(B.98)

$$+ a_k e^{-i(\omega_k t + \theta_k)} H_{2-}^*(\omega_k, \omega_l) a_l e^{i(\omega_k t + \theta_l)}$$

$$+ a_k e^{-i(\omega_k t + \theta_k)} H_{2+}(\omega_k, \omega_l) a_l e^{i(\omega_k t + \theta_l)}$$

$$+ a_k e^{-i(\omega_k t + \theta_k)} H_{2+}^*(\omega_k, \omega_l) a_l e^{-i(\omega_k t + \theta_l)}]$$

where the superscript '*' denotes the complex conjugate. This can be rewritten in matrix form as:

$$x_2(t) = \frac{q}{2} \begin{bmatrix} \mathbf{a}_+^T & \mathbf{a}_+^{T*} \end{bmatrix} \begin{bmatrix} \mathbf{H}_{2-} & \mathbf{H}_{2+} \\ \mathbf{H}_{2+}^* & \mathbf{H}_{2-}^* \end{bmatrix} \begin{bmatrix} \mathbf{a}_+^* \\ \mathbf{a}_+ \end{bmatrix}$$

(B.99)

The $\mathbf{a}_+$ term in Equation (B.99) is a vector of complex Gaussian processes in time, given by:

$$a_+ = \begin{bmatrix} a_1 e^{i(\omega_1 t + \theta_1)} \\ . \\ . \\ a_N e^{i(\omega_N t + \theta_N)} \end{bmatrix}$$

(B.100)

The Hermitian symmetry in the $\mathbf{H}$ matrix guarantees that $x_2(t)$ remains a real process. The $\mathbf{a}_+$ vectors can be standardized by factoring the variances of the individual processes, σ_k of Equation (B.95), out and moving them into the $\mathbf{H}$ matrix. That is, define:

$$z_k = \frac{a_k e^{i(\omega_k t + \theta_k)}}{\sigma_k}$$

(B.101)

and rewrite Equation (B.99) as:

$$x_2(t) = \begin{bmatrix} \mathbf{z}_+^T & \mathbf{z}_+^{T*} \end{bmatrix} \begin{bmatrix} \mathbf{D} & \mathbf{S} \\ \mathbf{S}^* & \mathbf{D}^* \end{bmatrix} \begin{bmatrix} \mathbf{z}_+^* \\ \mathbf{z}_+ \end{bmatrix} \qquad x_2(t) = \mathbf{z}^H \Gamma \mathbf{z}$$

(B.102)

This results in the following definitions for the components of the Γ matrix, $\mathbf{D}$ and $\mathbf{S}$:

$$D_{kl} = \frac{q}{2}\sigma_k\sigma_l H_{2-}(\omega_k, \omega_l) \qquad\qquad S_{kl} = \frac{q}{2}\sigma_k\sigma_l H_{2+}(\omega_k, \omega_l) \tag{B.103}$$

The standardized vector $\mathbf{z}$ is now composed of independent, standard normal process, such that the covariance matrix is:

$$\Sigma_{\mathbf{zz}} = E[\mathbf{z}\mathbf{z}^H] = \mathbf{I} \tag{B.104}$$

However, calculation of the statistics of $x_2(t)$ based on $\mathbf{z}(t)$ is still complicated by the non-zero off-diagonal elements in the Γ matrix. The solution is to factor Γ into a product of rotation matrices and a diagonal matrix via an eigenvalue analysis. A conventional eigenvalue analysis of the Hermitian Γ matrix provides the eigenvalues λ_j and the eigenvectors ϕ_j:

$$\Gamma\phi_j = \lambda_j\phi_j \quad ; \quad j = 1, \ldots 2N \tag{B.105}$$

The eigenvectors are normalized to have unit length:

$$|\phi_j|^2 = \phi_j^H\phi_j = 1 \tag{B.106}$$

The eigenvectors can also be scaled (rotated) such that the top half is the conjugate of the bottom half, providing symmetry similar to that observed in the $\mathbf{z}$ vector, i.e.:

$$\begin{Bmatrix} \phi_{1j} \\ . \\ . \\ \phi_{Nj} \end{Bmatrix} = \begin{Bmatrix} \phi^*_{N+1,j} \\ . \\ . \\ \phi^*_{2N,j} \end{Bmatrix} \tag{B.107}$$

The Γ matrix can then be decomposed into:

$$\Gamma = \Phi\Lambda\Phi^H \tag{B.108}$$

using the $2N$ x $2N$ matrix of eigenvectors Φ and the diagonal matrix of eigenvalues Λ. Substituting Equation (B.108) into Equation (B.102) leads to:

$$x_2(t) = \mathbf{z}^H\Phi\Lambda\Phi^H\mathbf{z} = \mathbf{u}^H\Lambda\mathbf{u} \tag{B.109}$$

This equation implies the definition of $\mathbf{u}$:

$$\mathbf{u} = \Phi^H\mathbf{z} \tag{B.110}$$

Due to the normalization and rotation of Φ discussed above, $\mathbf{u}$ is now a vector of real, standard Gaussian processes in time. This allows the writing of Equation (B.109) as a single sum:

$$x_2(t) = \sum_{j=1}^{2N} \lambda_j u_j^2(t) \tag{B.111}$$

In Equation (B.111), the second order response $x_2(t)$ has been written as a sum of standard normal processes $u_j(t)$ squared.

Returning now to the first order response, $x_1(t)$, the summation in Equation (B.96) can also be written in matrix form, as:

$$x_1(t) = \frac{1}{2} \begin{bmatrix} \mathbf{H}_1^{T*} & \mathbf{H}_1^{T} \end{bmatrix} \begin{bmatrix} \mathbf{a}_+^* \\ \mathbf{a}_+ \end{bmatrix} \tag{B.112}$$

where $\mathbf{a}_+$ is as before, and $\mathbf{H}_1$ is the vector of first order transfer function values:

$$\mathbf{H}_1 = \begin{Bmatrix} H_1(\omega_1) \\ \cdot \\ \cdot \\ H_1(\omega_N) \end{Bmatrix} \tag{B.113}$$

Again, the vector of Gaussian processes is standardized by factoring the variances σ_k into the transfer function values:

$$x_1(t) = \begin{bmatrix} \gamma_+^{T*} & \gamma^T \end{bmatrix} \begin{bmatrix} \mathbf{z}_+^* \\ \mathbf{z}_+ \end{bmatrix} = \gamma^H \mathbf{z} \tag{B.114}$$

with the following definition of γ_+:

$$\gamma_{+k} = \frac{1}{2} \sigma_{k H_1}(\omega_k); \quad k = 1, N \tag{B.115}$$

Equation (B.109) however provides the definition:

$$\mathbf{z} = \Phi \mathbf{u} \tag{B.116}$$

which can be substituted into Equation (B.114) to give:

$$x_1(t) = \gamma \Phi \mathbf{u} = \sum_{j=1}^{2N} c_j u_j \tag{B.117}$$

Equation (B.117) imply the definition of the c_j's:

$$c_j = \frac{1}{2} \sum_{k=1}^{2N} [H_1^*(\omega_k)\sigma_k \phi_{jk} + H_1(\omega_k)\sigma_k \phi_{jN+k}] \tag{B.118}$$

The c_j's are real by virtue of the conjugate symmetry in the scaled eigenvectors. In Equation (B.117), the first order response $x_1(t)$ has been written as a sum of the same standard normal processes $u_j(t)$ that appear in the second order response expression.

B 6.3   Response statistics

Thus the total combined response to the N frequency components of input has been restated in terms of $2N$ real, standard normal processes:

$$x(t) = x_1(t) + x_2(t) \tag{B.119}$$

where $x(t) = \sum_{j=1}^{2N} [c_j u_j(t) + \lambda_j u_j^2(t)]$

The statistics of $x(t)$ can now be computed in terms of the c's and λ's, and the moments of the $u_j(t)$ processes. From Equation (B.119):

$$x(t) = \sum_{j=1}^{2N} Q_j(t) \tag{B.120}$$

where $Q_j(t) = c_j u_j(t) + \lambda_j u_j^2(t)$

Note that at fixed time t, the quadratic random variables $Q_j(t)$ are independent. Computations are therefore simplified by considering not the ordinary moments of $x(t)$ but rather its {.I cumulants} $\kappa_n[x(t)]$, because cumulants of independent components can be directly summed:

$$\kappa_n[x(t)] = \sum_j \kappa_n[Q_j(t)] \tag{B.121}$$

We focus here on the first four cumulants: $\kappa_1[x]=m_x$, $\kappa_2[x]=\sigma_x^2$, $\kappa_3[x]=\alpha_3\sigma_x^3$, and $\kappa_4[x]=(\alpha_{4-3})\sigma_x^4$. Note that $\kappa_2[x]=\mu_2$ and $\kappa_3[x]=\mu_3$ in terms of the central moments $\mu_n=E[(x-m_x)^n]$, while $\kappa_4[x]=\mu_4-3\mu_2^2$. Because $E[u_j]=0$ and $E[u_j^2]=1$, the first cumulant (mean value) is:

$$\kappa_1[Q_j(t)] = \overline{Q}_j = \lambda_j \tag{B.122}$$

For notational simplicity, we shall use the overbar as an alternative symbol for ensemble expectation.

For general central moments of the form $\overline{(Q_j(t) - \overline{Q}_j)^n}$, it is useful to subtract Equation (B.122) from Equation (B.120) before averaging:

$$Q_{0j}(t) = Q_j(t) - \overline{Q}_j = c_j u_j(t) + \lambda_j u_{2j}(t) \tag{B.123}$$

Here $u_{2j} = u_j^2 - 1$ is the second Hermite polynomial, which has zero mean and is uncorrelated with u_j. The variance of $Q_j(t)$ follows by squaring Equation (B.123) and taking averages:

$$\kappa_2[Q_j(t)] = \overline{(Q_j(t) - \overline{Q}_j)^2} = c_j^2 \overline{u_j^2} + 2c_j\lambda_j \overline{u_j u_{2j}} + \lambda_j^2 \overline{u_{2j}^2} \tag{B.124}$$

Using the moment property $E[u_j^{2n}] = 1 \cdot 3 \cdots (2n-1)$ for standard normal variables, we find that $\overline{u_i^2} = 1$, $\overline{u_j u_{2j}} = 0$, and $\overline{u_{2j}^2} = 2$. Substituting these values into Equation (B.124) gives:

$$\kappa_2[Q_j(t)] = \overline{(Q_j(t) - \overline{Q}_j)^2} = c_j^2 + 2\lambda_j^2 \tag{B.125}$$

Higher central moments, $\overline{Q_{0i}^n}$, are found similarly. Explicit results for $\overline{Q_{0j}^3}$ and $\overline{Q_{0j}^4}$ are:

$$\overline{Q_{0j}^3(t)} = \overline{(Q_j(t) - \bar{x})^3} = c_j^3 \overline{u_j^3} + 3c_j^2\lambda_j \overline{u_j^2 u_{2j}} + 3c_j\lambda_j^2 \overline{u_j u_{2j}^2} + \lambda_j^3 \overline{u_{2j}^3} \tag{B.126}$$

$$\overline{Q_{0j}^4(t)} = \overline{(Q_j(t) - \bar{x})^4} = c_j^4 \overline{u_j^4} + 4c_j^3\lambda_j \overline{u_j^3 u_{2j}} + 6c_j^2\lambda_j^2 \overline{u_j^2 u_{2j}^2} + 4c_j\lambda_j^3 \overline{u_j u_{2j}^3} + \lambda_j^4 \overline{u_{2j}^4} \tag{B.127}$$

Again using the Gaussian moment property, the only non zero quantities in these expressions are found to be $\overline{u_j^2 u_{2j}} = 2$, $\overline{u_{2j}^3} = 8$, $\overline{u_j^4} = 3$, $\overline{u_j^2 u_{2j}^2} = 10$ and $\overline{u_{2j}^4} = 60$. Substituting into Equation (B.126) and Equation (B.127), we find the cumulant values:

$$\kappa_3[Q_j(t)] = 6c_j^2\lambda_j + 8\lambda_j^3 \tag{B.128}$$

$$\kappa_4[Q_j(t)] = 48\lambda_j^2(c_j^2 + \lambda_j^2) \tag{B.129}$$

The total cumulants of $x(t)$ follow by summing Equation (B.122), Equation (B.125), Equation (B.128) and Equation (B.129) in accordance with Equation (B.121). The moments of $x(t)$ are then found to be:

$$\bar{x} = \sum_{k=1}^{2N} \lambda_k \tag{B.130}$$

$$\sigma_x^2 = \sum_{k=1}^{2N} (c_k^2 + 2\lambda_k^2) \tag{B.131}$$

$$\alpha_{3x} = \sum_{k=1}^{2N} (6c_k^2\lambda_k + 8\lambda_k^3)/\sigma_x^3 \tag{B.132}$$

$$\alpha_{4x} = \sum_{k=1}^{2N} 48\lambda_k^2(c_k^2 + \lambda_k^2)/\sigma_x^4 + 3 \tag{B.133}$$

In these equations, the κ's represent pure second order effects, the c's represent pure first order effects, and terms with products of κ's and c's represent interaction of first and second order effects.

B 7   Frequency Domain Fatigue

B 7.1   Basic Assumption

There are two basic assumptions. First, stress cycles are assumed to occur with mean rate ν_0, and an arbitrary stress range S is assumed to have Weibull distribution with scale parameter a and shape parameter b:

$$F_s(x) \;=\; P[S \le x] \;=\; 1 - \exp\left[-\left(\frac{x}{a}\right)^b\right] \tag{B.134}$$

This can include both linear as well as linear response, provided appropriate choices of a and b are made based on the non linearity, ref. Winterstein, Ref. /10/. Secondly, we assume a single-slope S-N-curve:

$$N(S) \;=\; KS^{-m} \tag{B.135}$$

or for a bilinear SN-curve:

$$N(S) = KS^{-m}, \quad S \ge S_0; \quad N(S) = K_2 S^{-m_2}, \quad S < S_0 \tag{B.136}$$

In this case the user inputs m_2 as well as m and K. The parameter K_2 is given by:

$$K_2 \;=\; KS_0^{-m + m_2} \tag{B.137}$$

to ensure continuity between the two curves.

B 7.2   Basic results

The basic result calculated by Postresp is the damage rate, *DR*, per unit time. This is given by:

$$DR(K, m, a, b, \nu_0) \;=\; \frac{\nu_0}{K \cdot E[S^m]} \;=\; \frac{\nu_0}{K \cdot \Gamma\!\left(1 + \dfrac{m}{b}\right)} \tag{B.138}$$

in which Γ is the standard Gamma function. The corresponding total damage in period T_d is:

$$D_{tot} \;=\; T_d \cdot DR(K, m, a, b, \nu_0) \tag{B.139}$$

The parameters K, m and T_d should be input by the user of the fatigue analysis, while the parameters a, b, and ν_0 is calculated internally by Postresp. This is described in the following chapters for the various cases of interest.

For the bilinear SN-curve, the damage rate in Equation (B.138) is replaced by

$$DR(K, m, m_2, a, b, \nu_0) = \frac{\nu_0}{K_2} a^{m_2} \cdot \gamma\left(1 + \frac{m_2}{b}, \left(\frac{S_0}{a}\right)^b\right) + \frac{\nu_0}{Ka^m}\left[\Gamma\left(\frac{1+m}{b} - \gamma\left(\frac{1+m}{b}\right), \left(\frac{S_0}{a}\right)^b\right)\right] \quad \text{(B.140)}$$

in which γ is the incomplete Gamma function.

B 7.3   Short Term Fatigue; Linear Model

In this case the stress range is assumed to have Rayleigh distribution, with parameters based on the spectral moments, M_0 and M_2 (M_c defined as in Equation (B.69)). In this case the parameters a, b, and ν_0 are as follows:

$$b = 2; \quad a = \sqrt{8M_0}; \quad \nu_0 = \frac{1}{2\pi}\sqrt{\frac{M_2}{M_0}} \quad \text{(B.141)}$$

B 7.4   Long Term Fatigue, Sum over Seastates

A long term fatigue analysis focuses on the total damage, $\overline{D}_{tot}$, contributed by all seastates and all headings. The preferred calculation method is to evaluate the foregoing short term results over all such seastate/heading cases, $i = 1, ..., N$, and weight by the relative frequencies p_i, of these various cases:

$$\overline{D}_{tot} = \sum_i p_i D_{tot, i} = T_d \cdot \sum_i p_i \cdot DR(K, m, a_i, b_i, \nu_{0i}) \quad \text{(B.142)}$$

Thus, the same damage rate function, DR should be calculated for all seastate/heading cases. As Equation (B.142) indicates, each of these will typically have different parameters a_i, b_i, and ν_{0i}. These should be evaluated from Equation (B.141). It may also be useful to consider some output that reflects not only the total damage $\overline{D}_{tot}$, but the relative contributions from the different seastates as well.

B 7.5   Long Term Fatigue from Long Term Distribution

Finally, as an alternative to Equation (B.142), the long term fatigue damage can be estimated directly from the long term Weibull stress distribution, already fitted in Postresp. As indicated in Section B 5, this leads to a cycle rate $\nu_{0,LT}$ and parameters a_{LT} and b_{LT} of a Weibull distribution (Equation (B.89)) that characterises an arbitrary stress cycle from the long term distribution. The long term damage is then estimated not from a loop over all seastate cases as in Equation (B.142), but rather as a single evaluation with these long term Weibull parameters.

$$\overline{D}_{tot} = T_d \cdot DR(K, m, a_{LT}, , b_{LT}, \nu_{LT}) \quad \text{(B.143)}$$

APPENDIX C   PULLDOWN MENUS AND DIALOGUE WINDOWS OF POSTRESP

This appendix shows the pulldown menus of the Postresp commands and dialogue windows connected to the items in the pulldown menus.

When clicking an item in the pull down menus, three different actions may take place; 1) the command initiates a program execution immediately, 2) the command opens a dialogue window through which user interaction may take place, 3) a subcommand list pops up to the right of the command. The action rules are illustrated below.

Action rules for items in the pulldown menu:
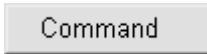
1 The command button   [Command]   initiates a program execution.

2 The command button   [Command...]   opens a dialogue window.

3 The command button   [Command ▸]   shows a list of subcommands to the right of the button.

C 1   POSTRESP dialogue window and commands
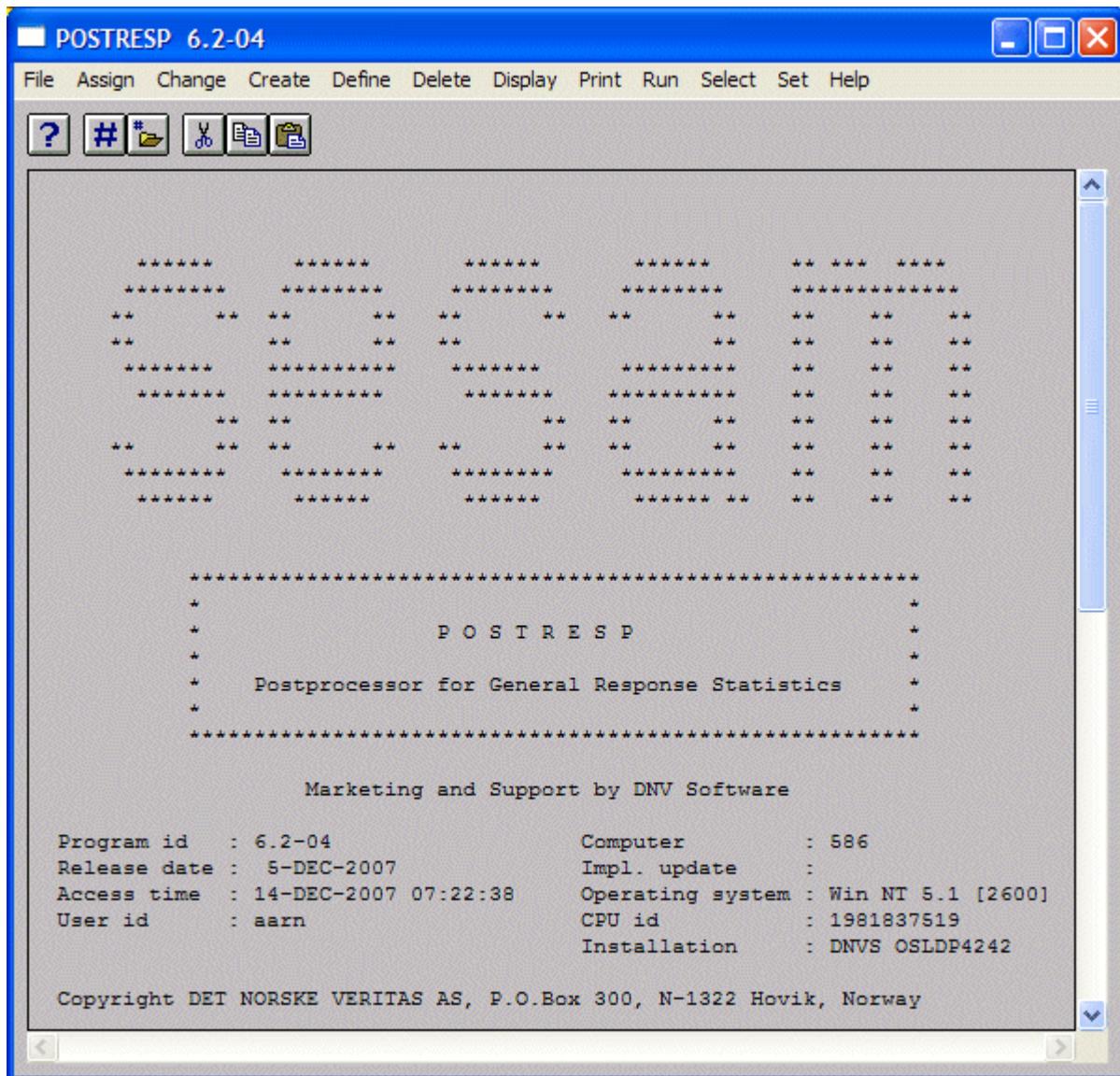
Figure C.1   POSTRESP dialogue window and commands

C 2   FILE Menu

Figure C.2   FILE pulldown menu
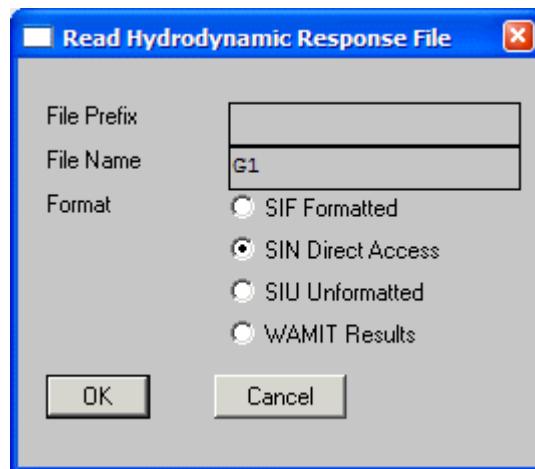
Figure C.3   FILE READ
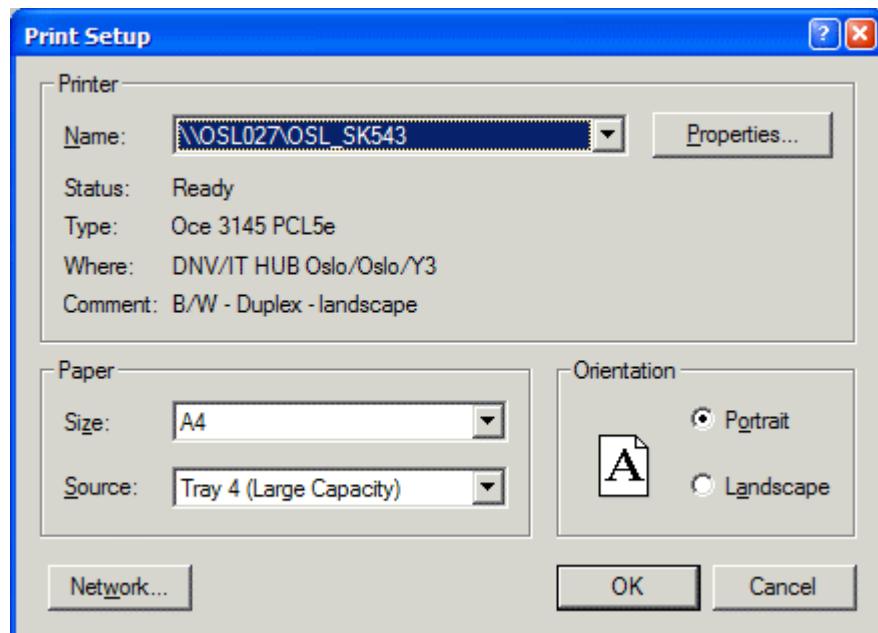
Figure C.4   FILE SELECT-PRINTER

C 3   ASSIGN Menu
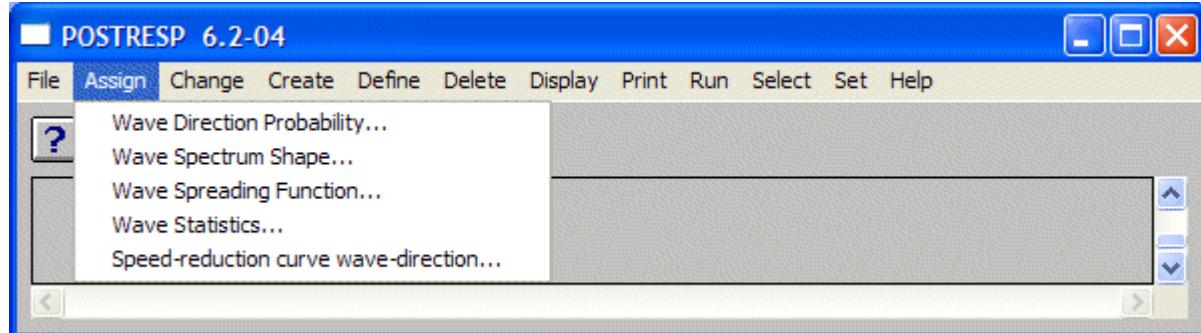
Figure C.5   ASSIGN pulldown menu
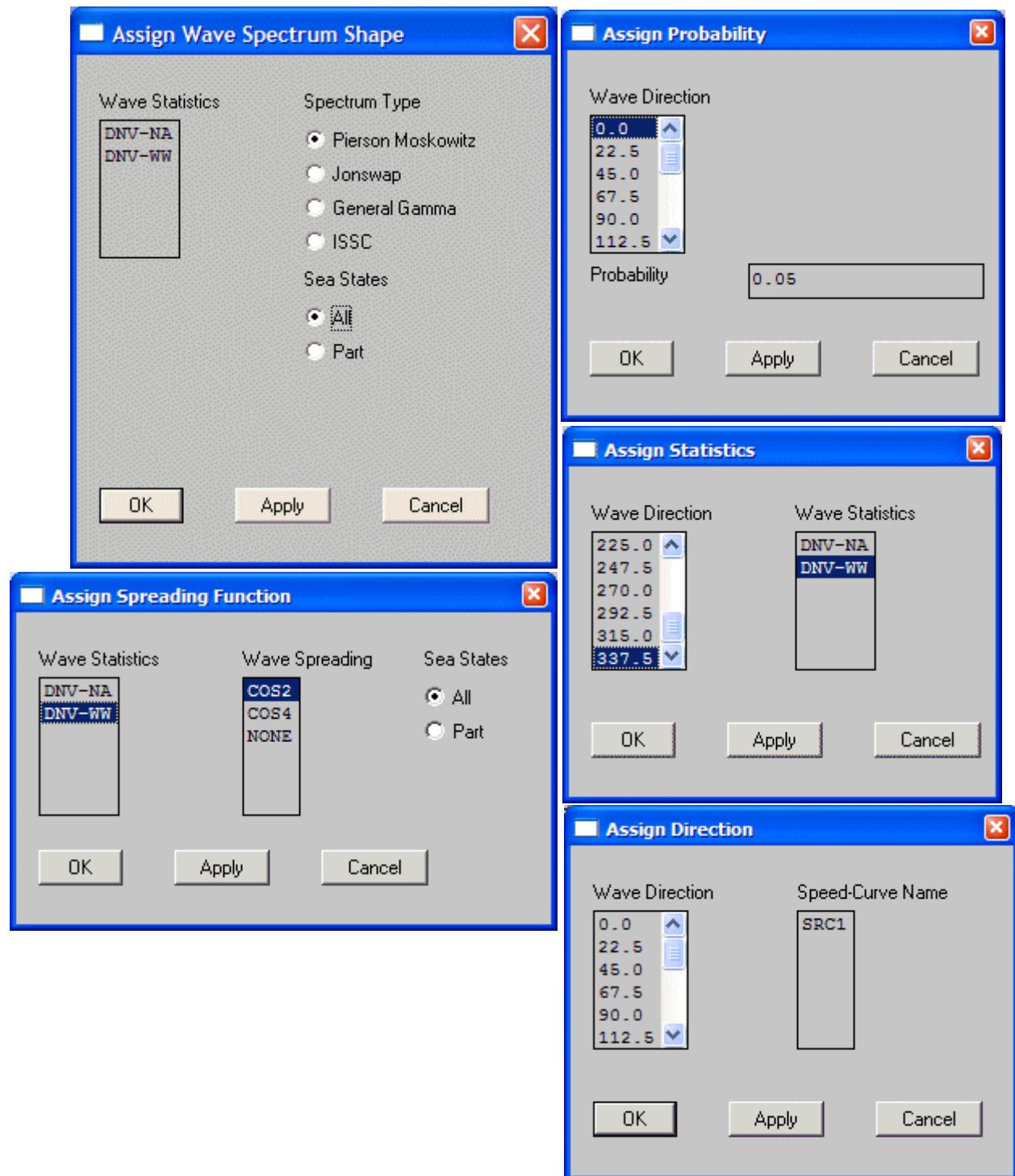
Figure C.6   ASSIGN: WAVE-SPECTRUM-SHAPE, WAVE-SPREADING-FUNCTION, WAVE-DIRECTION-PROBABILITY, WAVE-STATISTICS, SPEED-REDUCTION-CURVE-WAVE-DIRECTION

C 4   CHANGE Menu
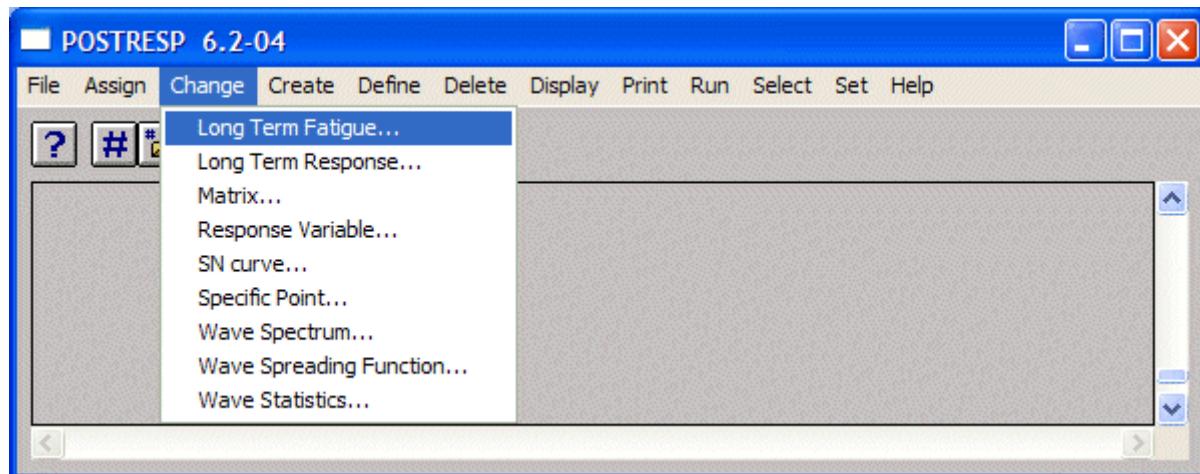
Figure C.7   CHANGE pulldown menu
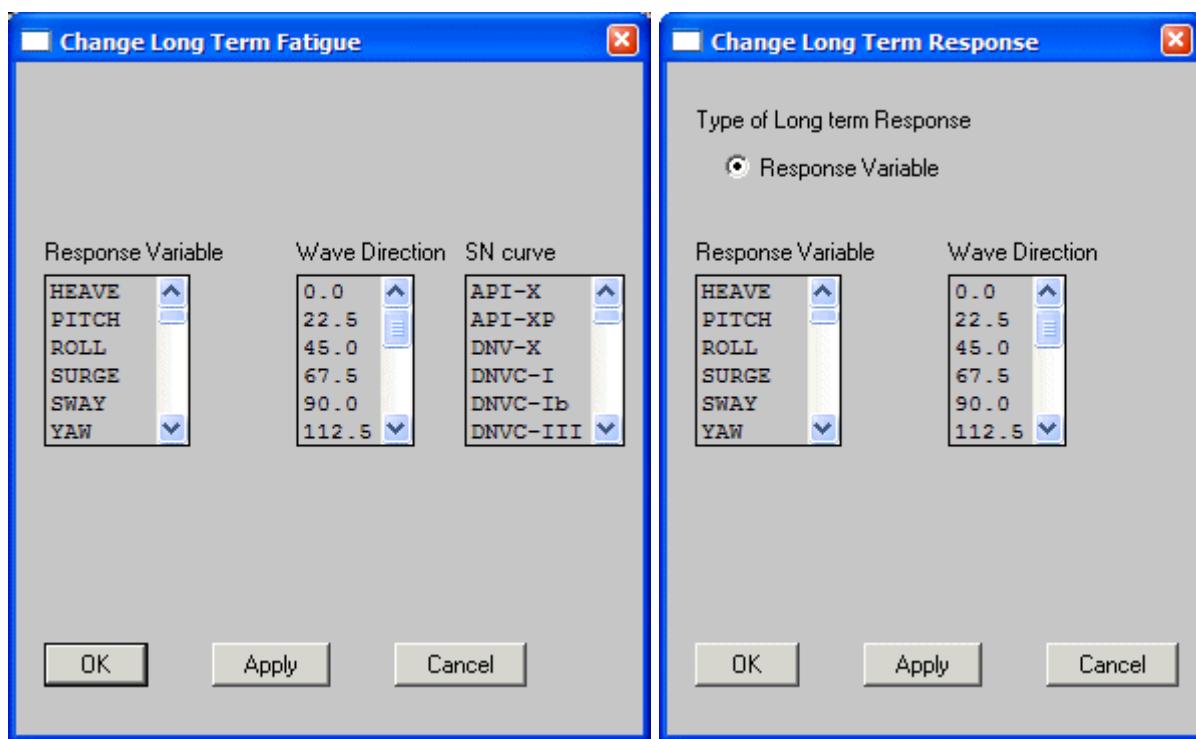
Figure C.8   CHANGE: LONG-TERM-FATIGUE, LONG-TERM-RESPONSE
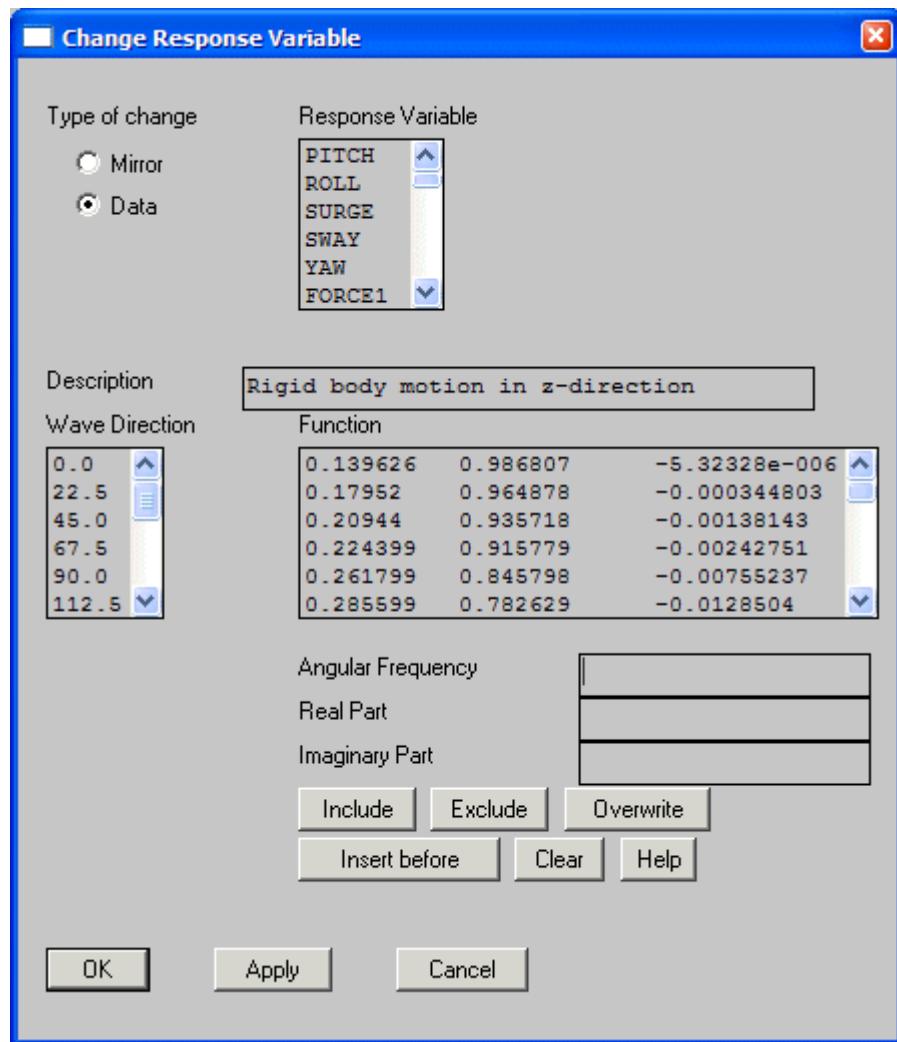
Figure C.9   CHANGE: RESPONSE-VARIABLE
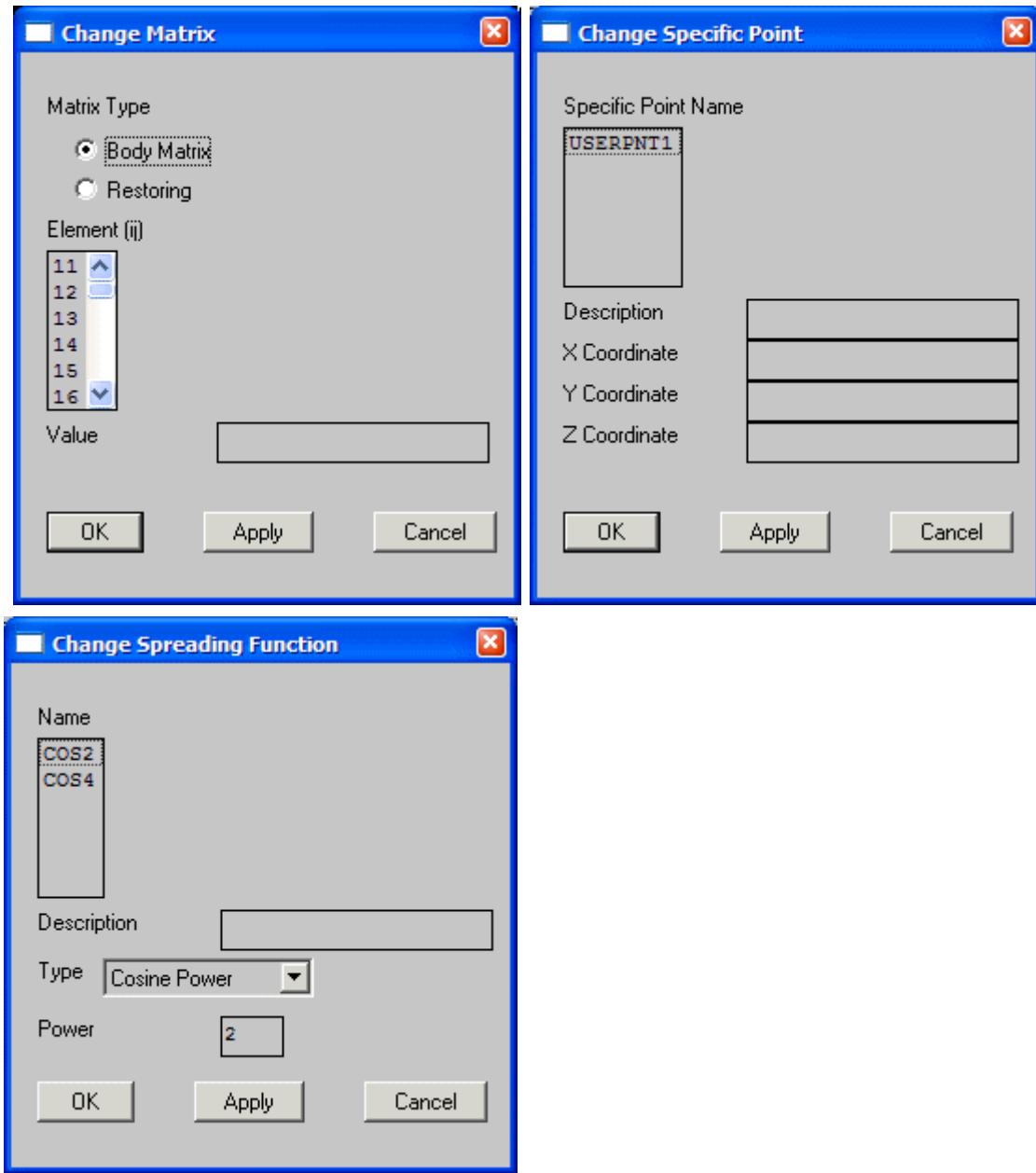
Figure C.10   CHANGE: MATRIX, SPECIFIC-POINT, WAVE-SPREADING-FUNCTION
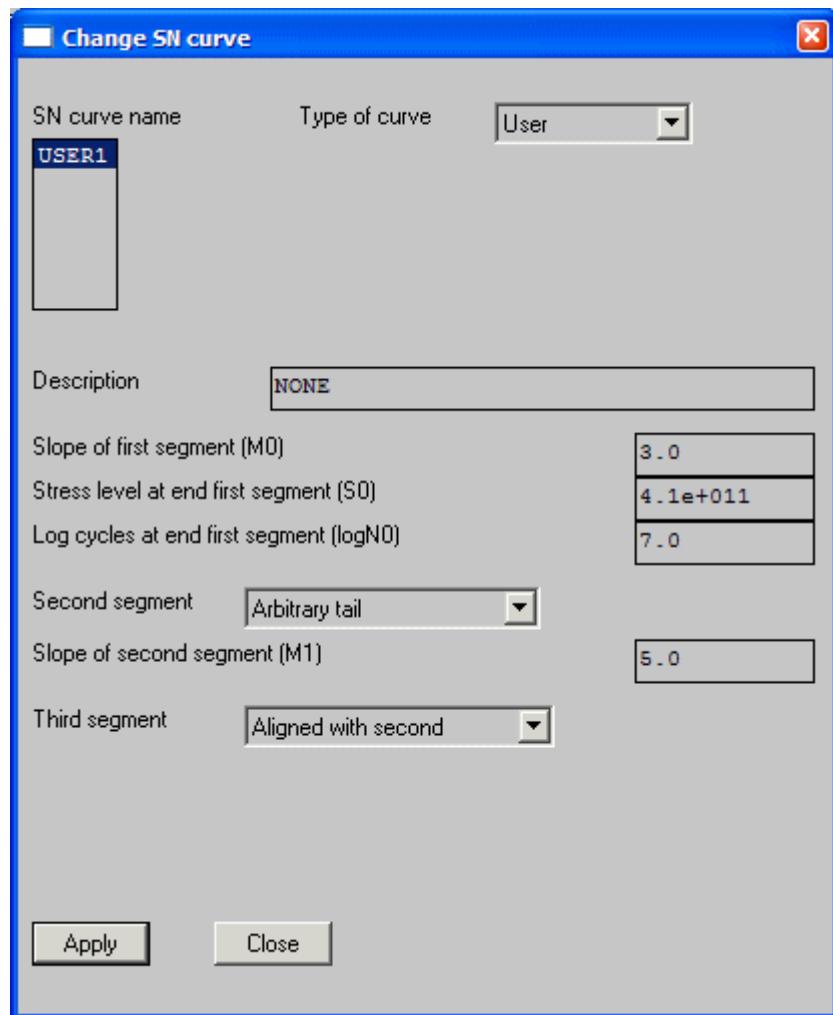
Figure C.11   CHANGE: SN-CURVE
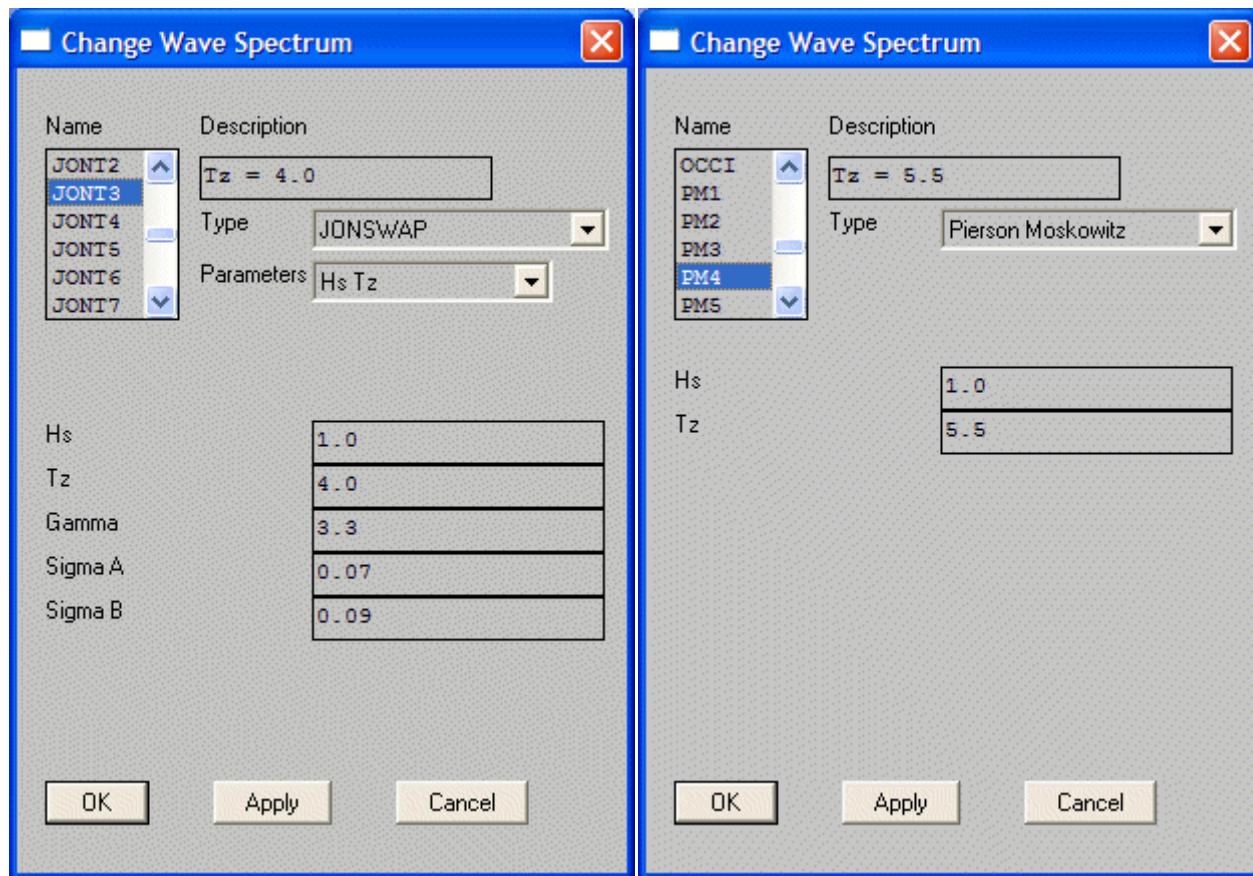
Figure C.12   CHANGE: WAVE-SPECTRUM
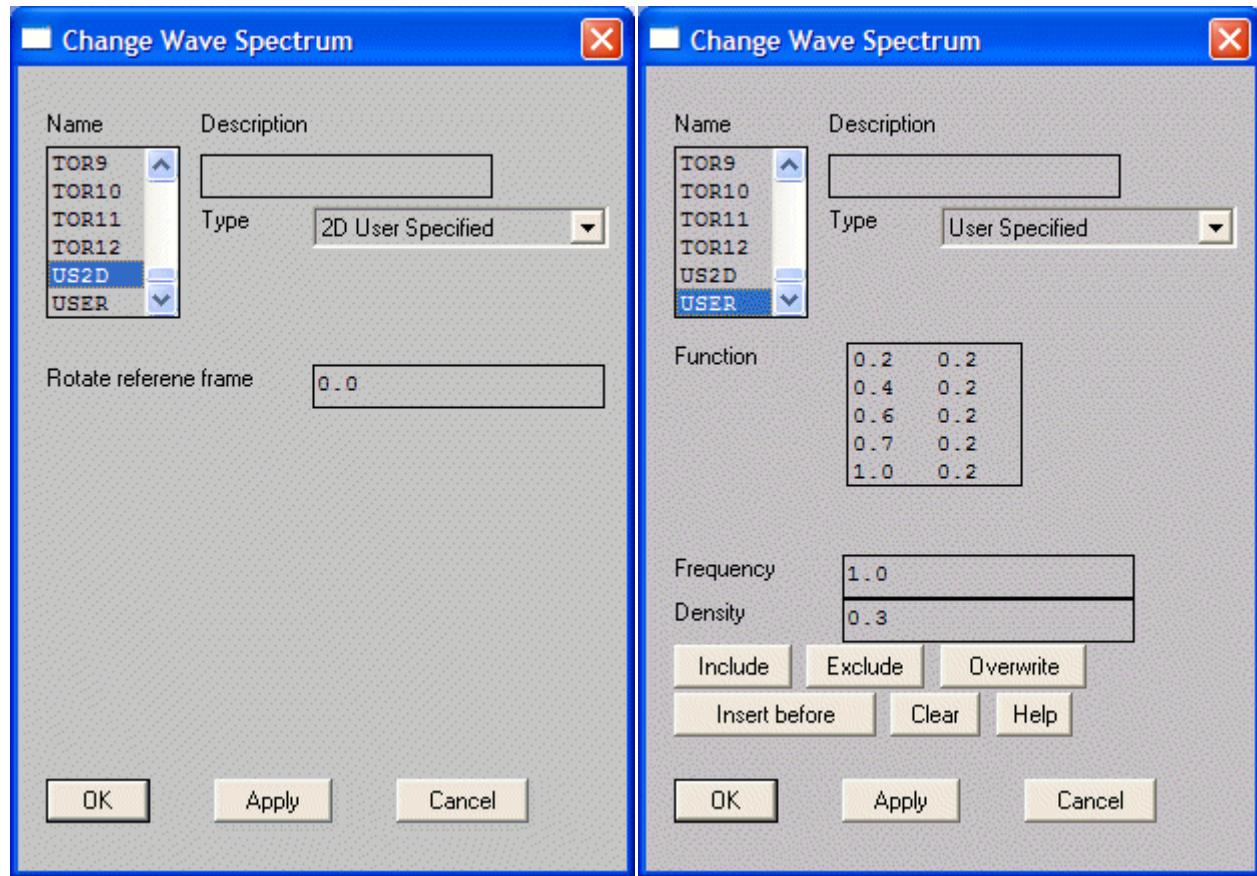
Figure C.13   CHANGE: WAVE-SPECTRUM
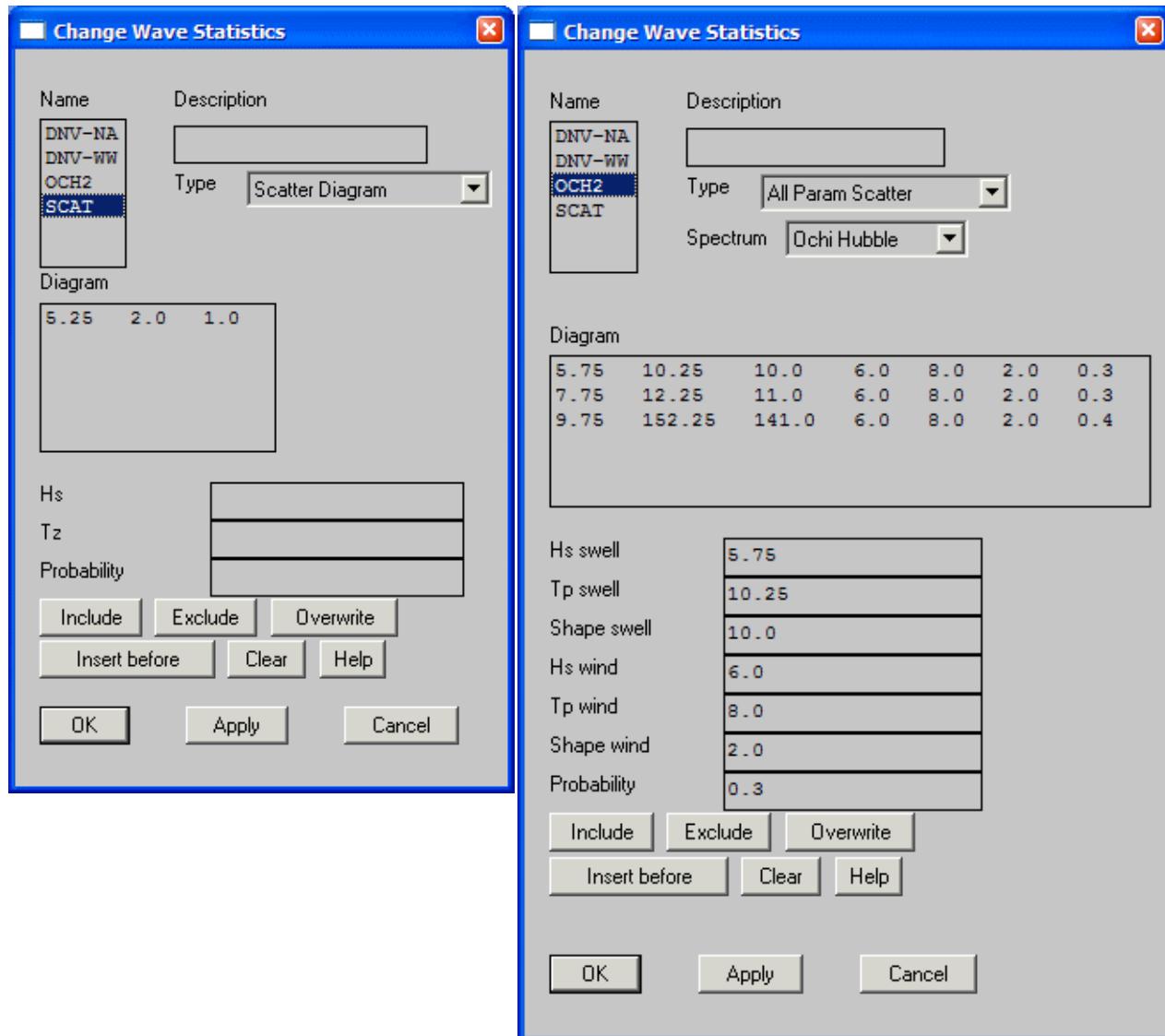
Figure C.14   CHANGE: WAVE-STATISTICS (Scatter Diagram, All Param Scatter)
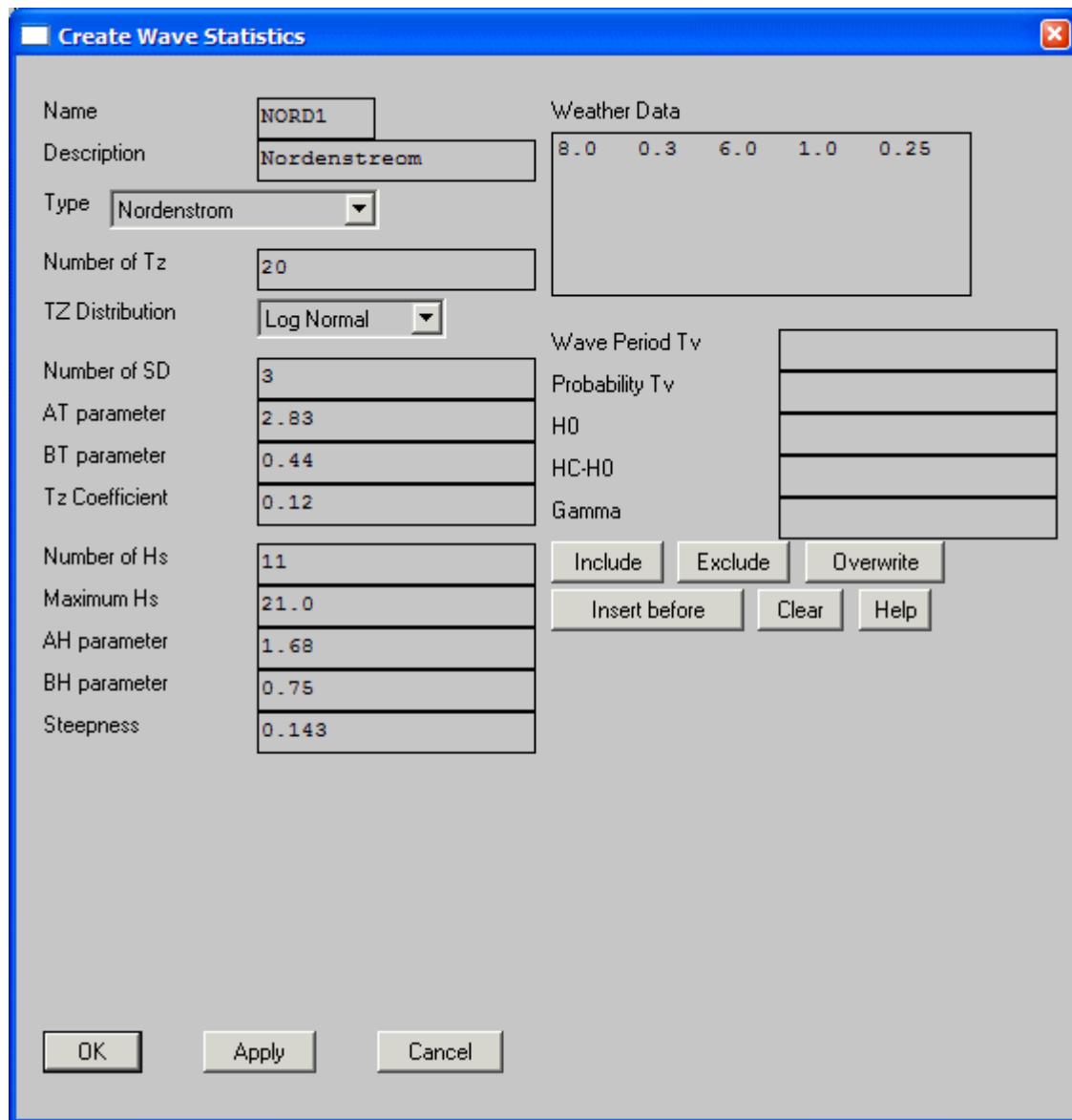
Figure C.15   CHANGE: WAVE-STATISTICS (Nordenstrom)

C 5   CREATE Menu
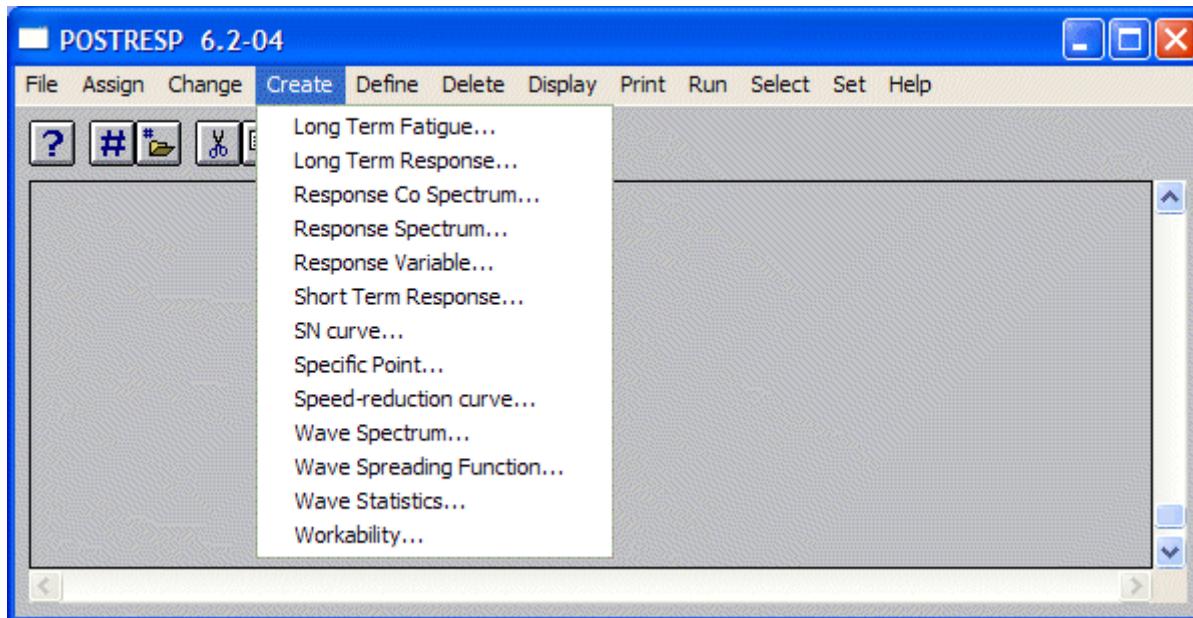
Figure C.16   CREATE pulldown menu
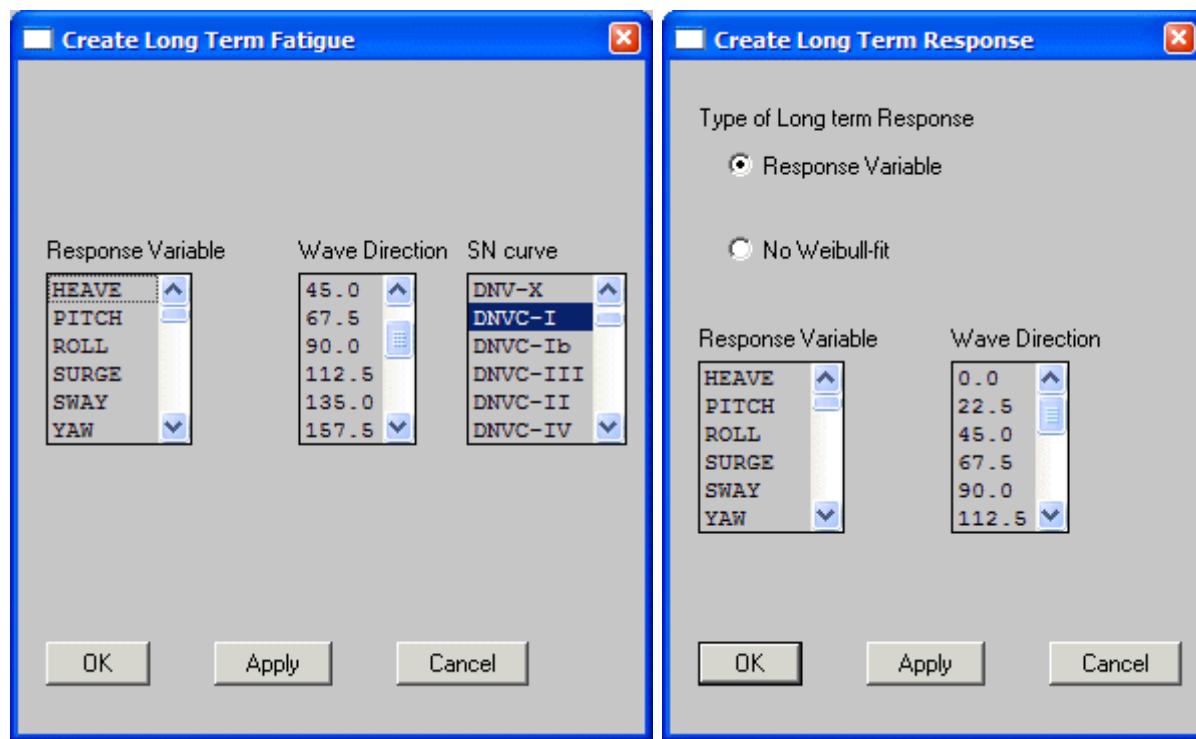
Figure C.17   CREATE: LONG-TERM-FATIGUE, LONG-TERM-RESPONSE
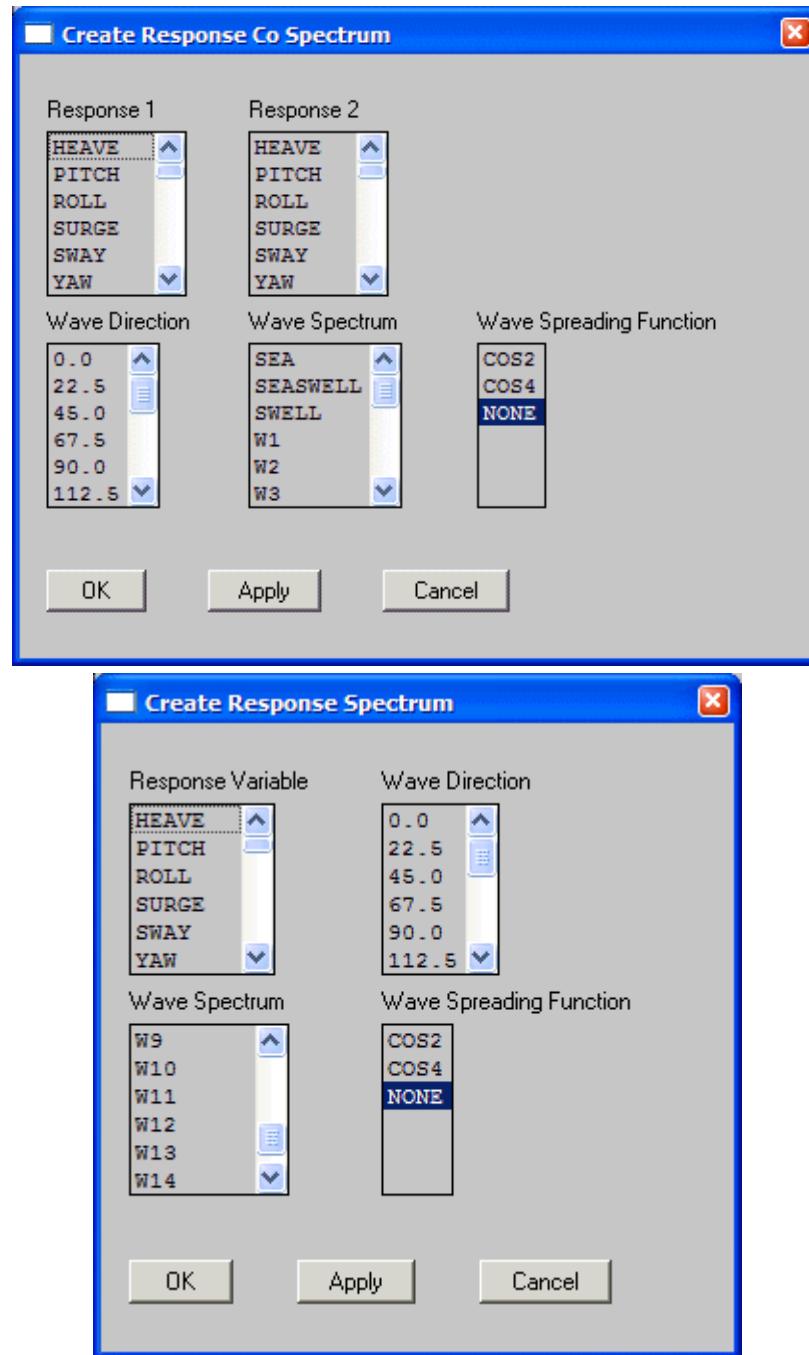
Figure C.18   CREATE: RESPONSE-CO-SPECTRUM, RESPONSE-SPECTRUM
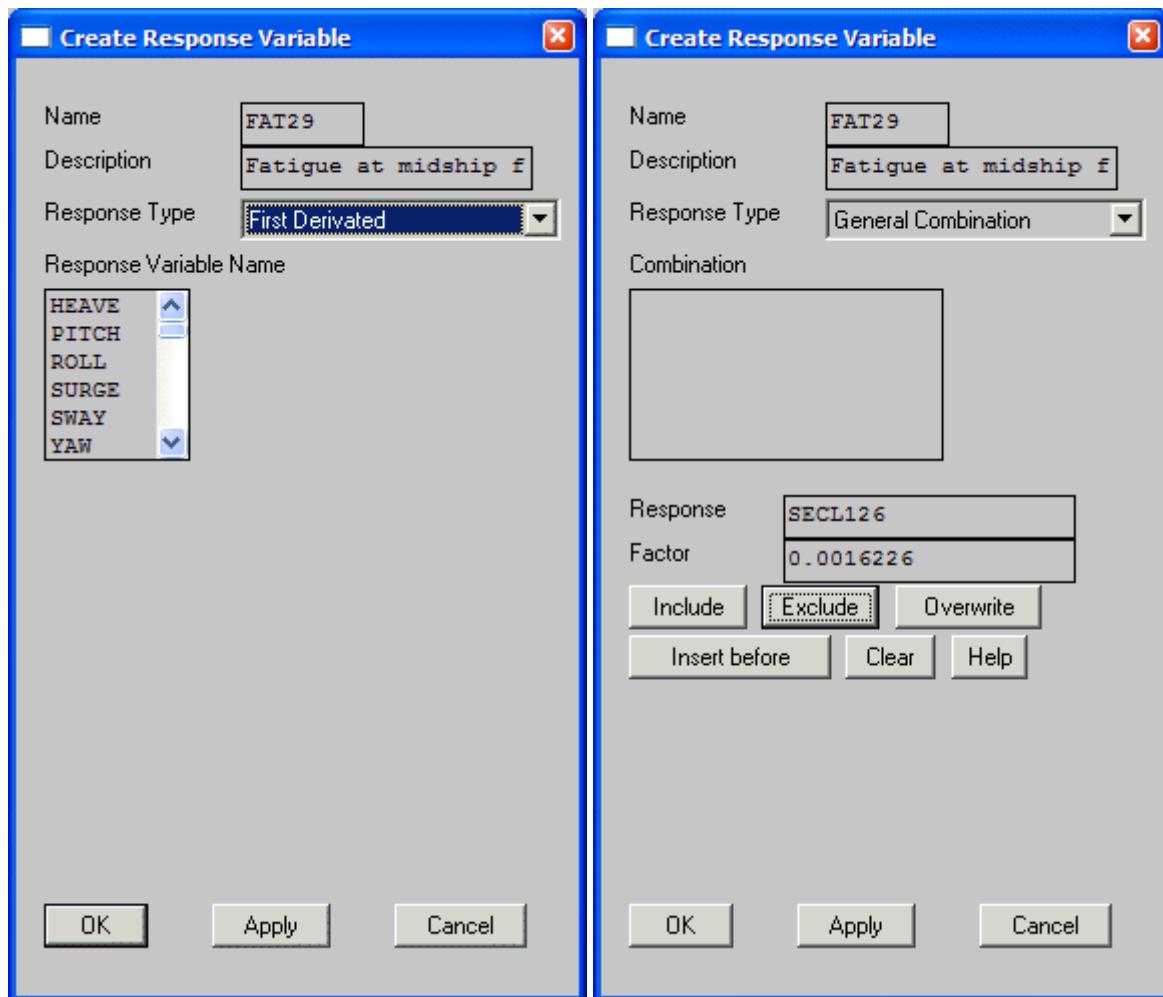
Figure C.19   CREATE: RESPONSE-VARIABLE (First Derivated, General Combination)
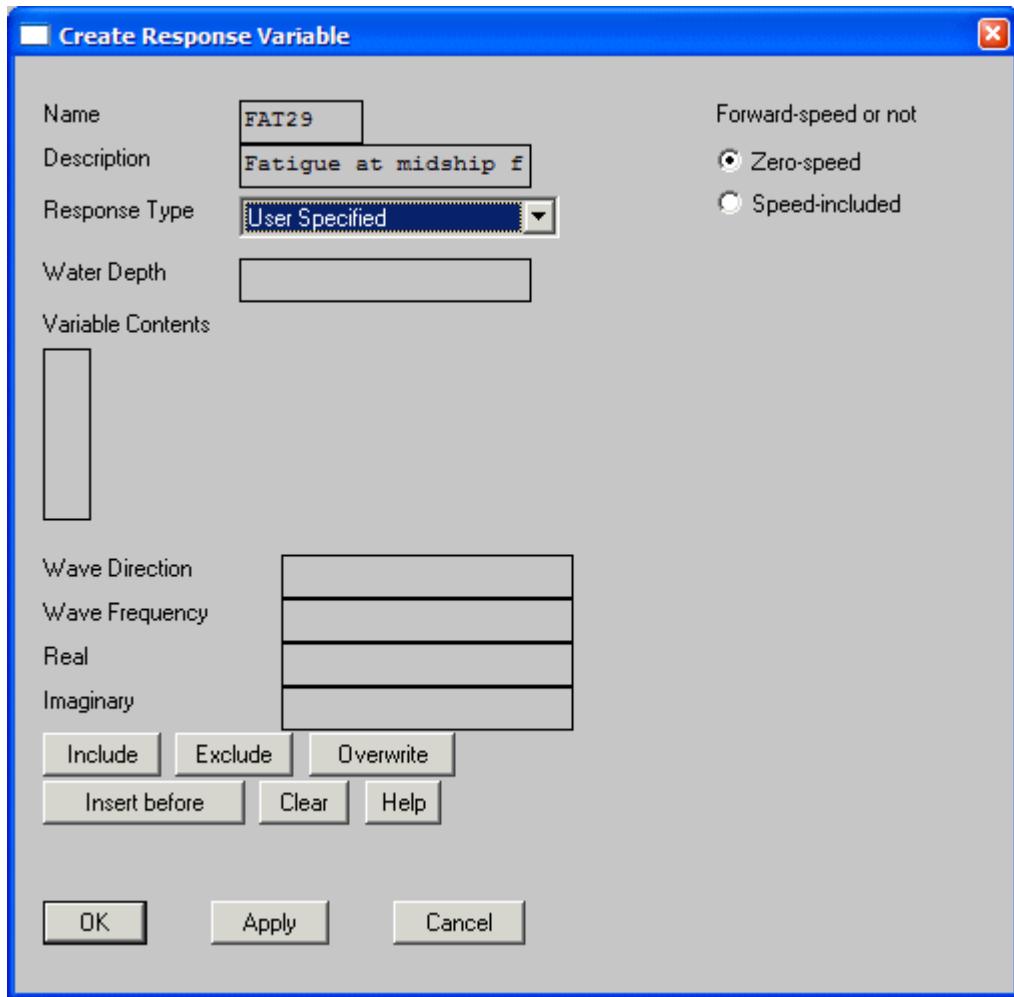
Figure C.20   CREATE: RESPONSE-VARIABLE (User Specified)
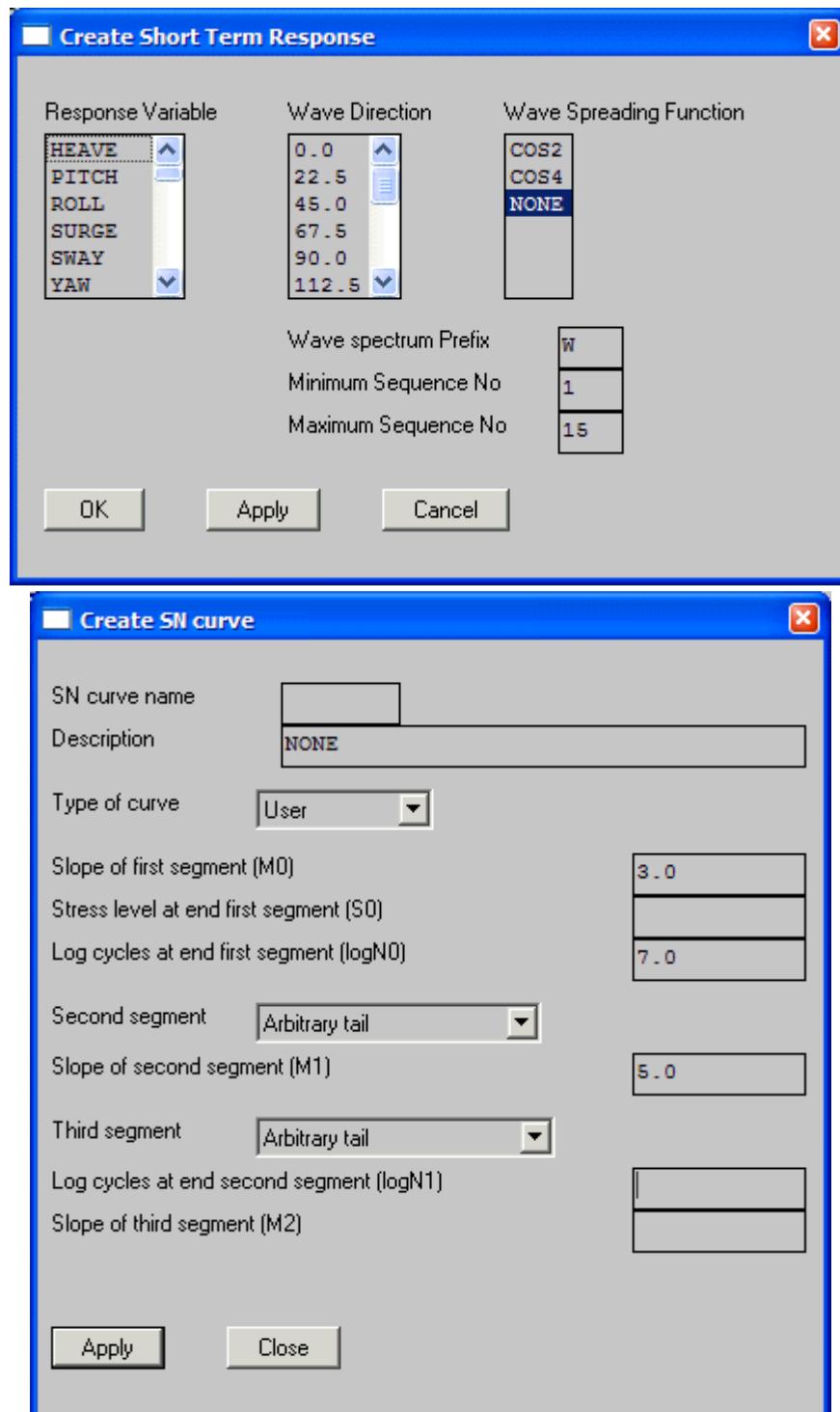
Figure C.21   CREATE: SHORT-TERM-RESPONSE, SN-CURVE
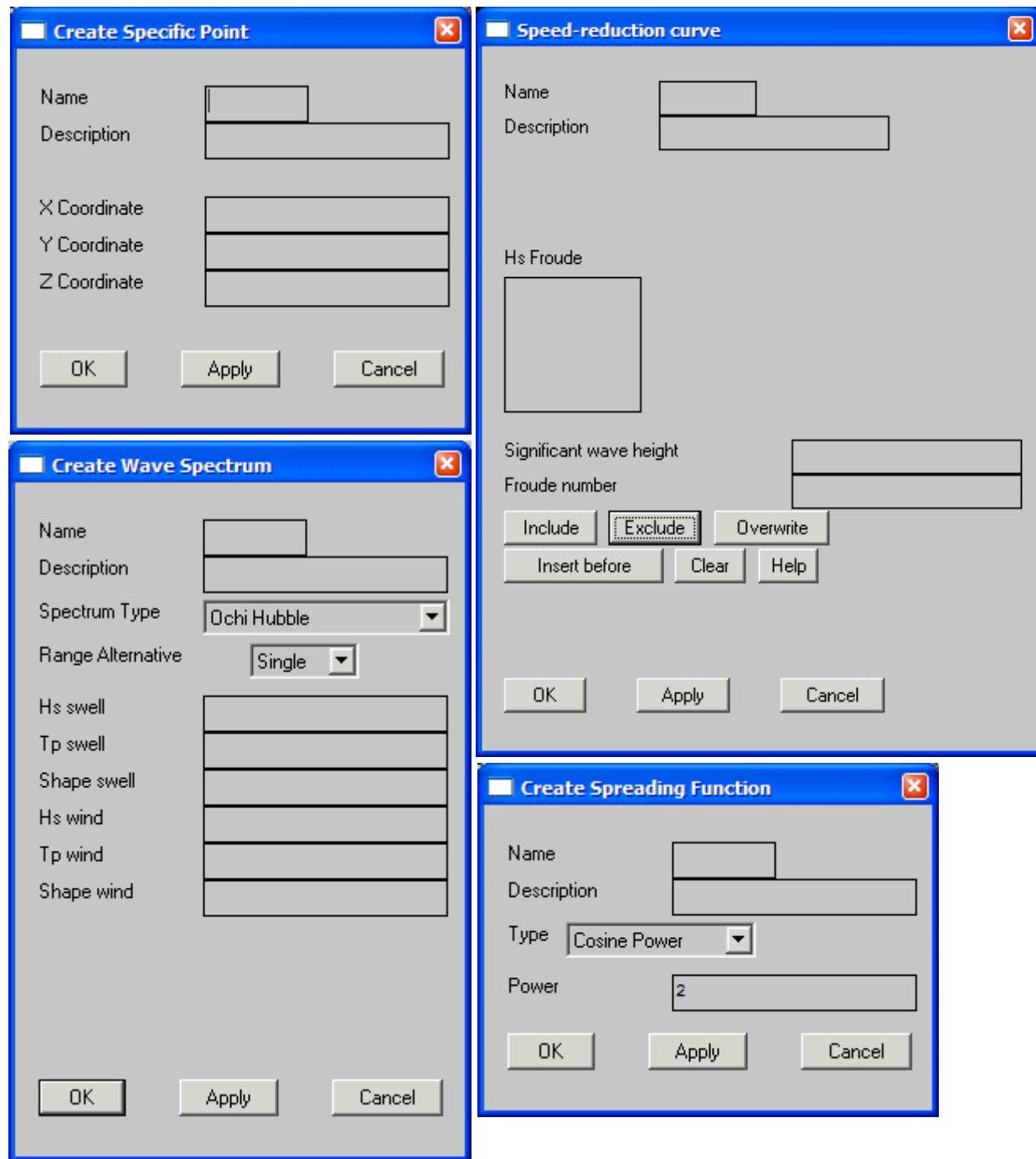
Figure C.22 CREATE: SPECIFIC-POINT, SPEED-REDUCTION-CURVE, WAVE-SPREADING-FUNCTION, WAVE-SPECTRUM (Ochi Hubble)
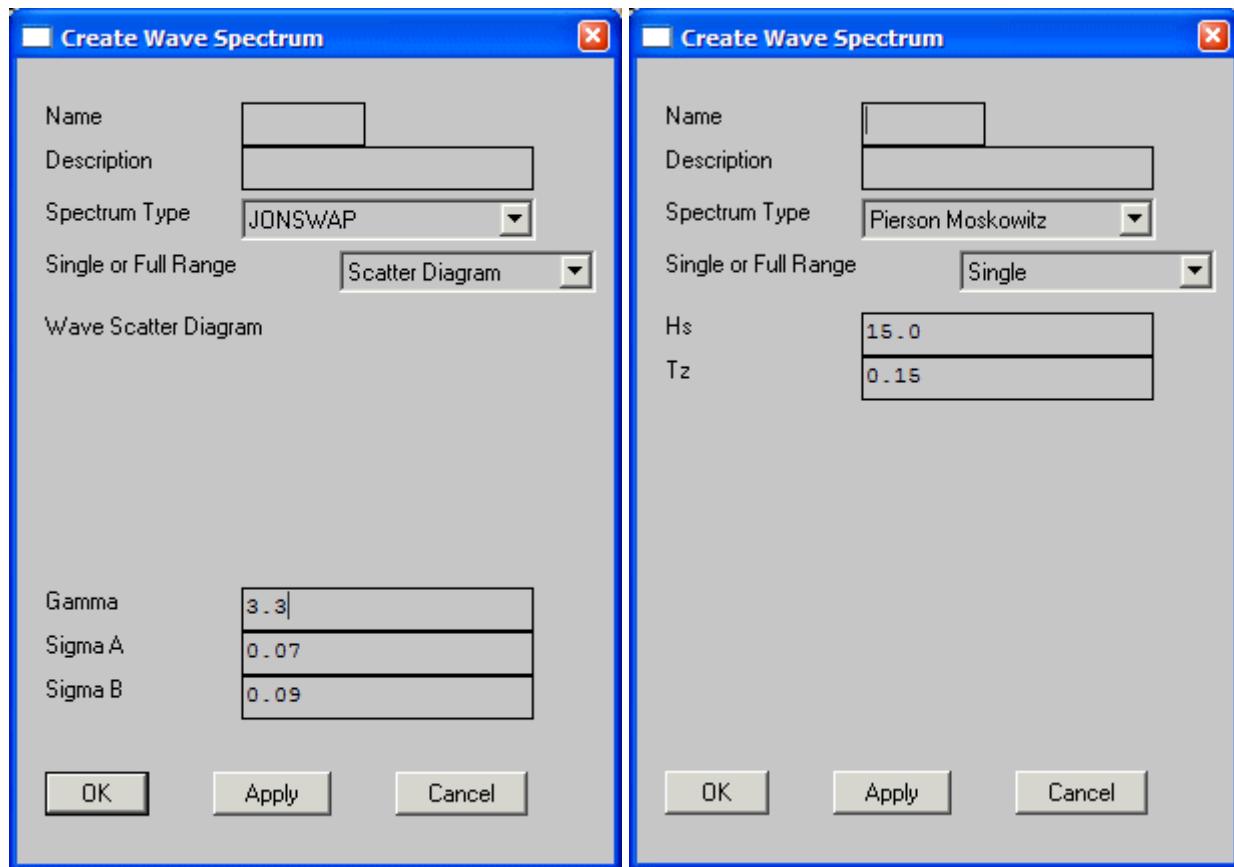
Figure C.23   CREATE: WAVE-SPECTRUM (Jonswap, Pierson Moskowitz)
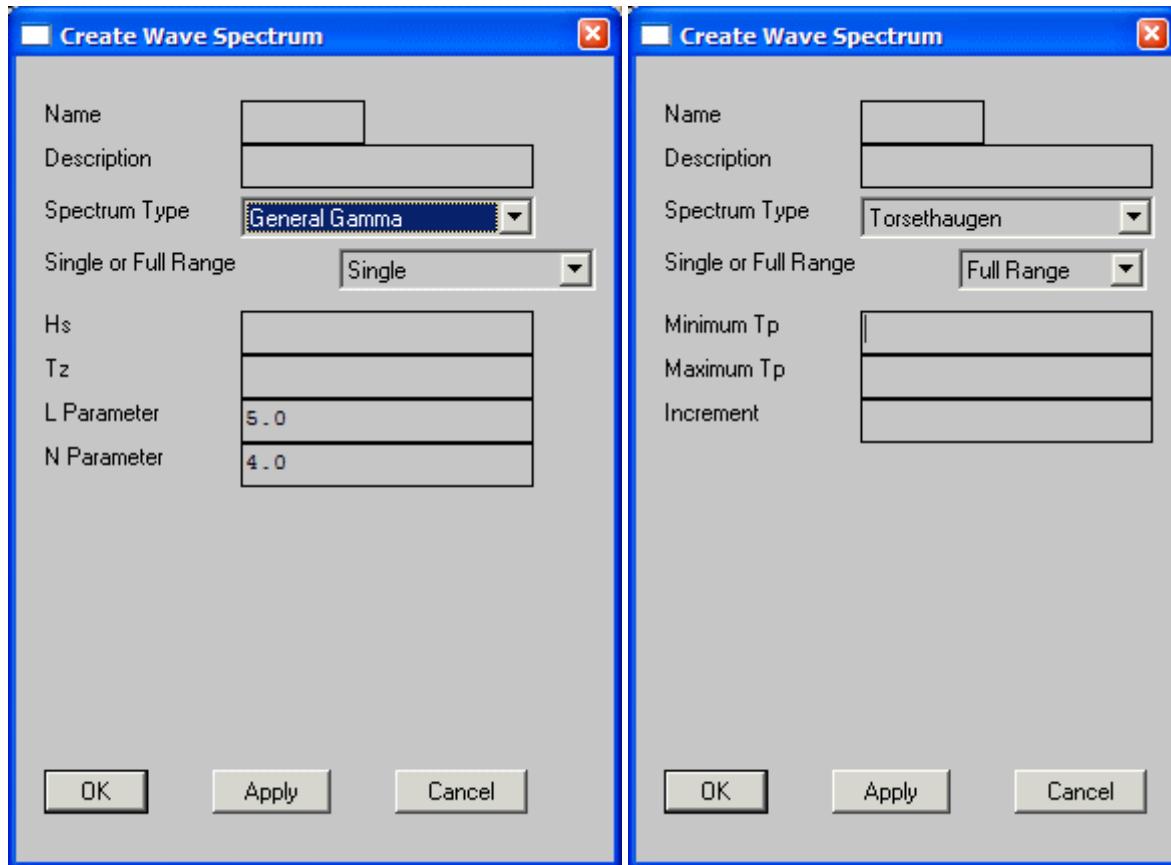
Figure C.24   CREATE: WAVE-SPECTRUM (General Gamma, Torsethaugen)
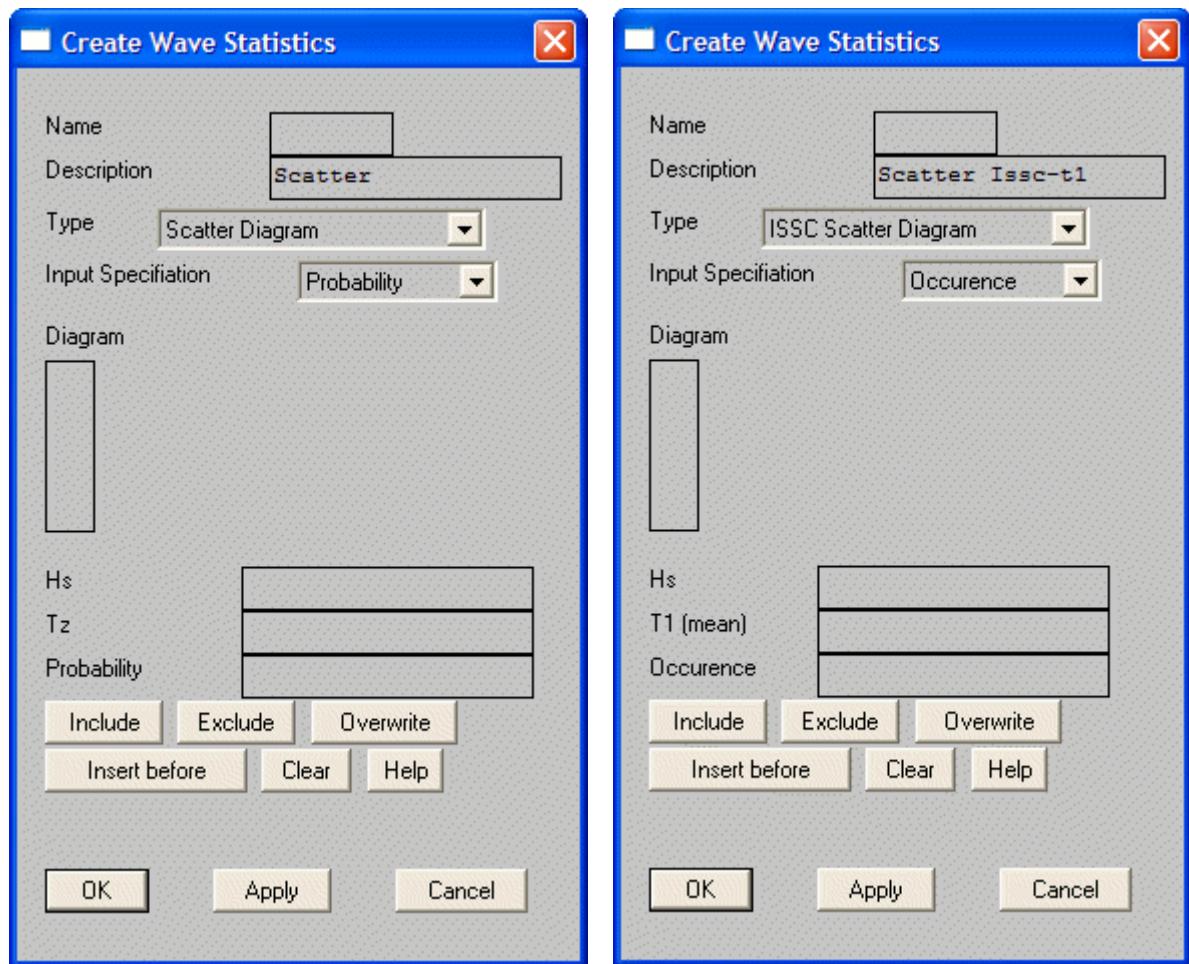
Figure C.25   CREATE: WAVE-STATISTICS (Scatter Diagram)
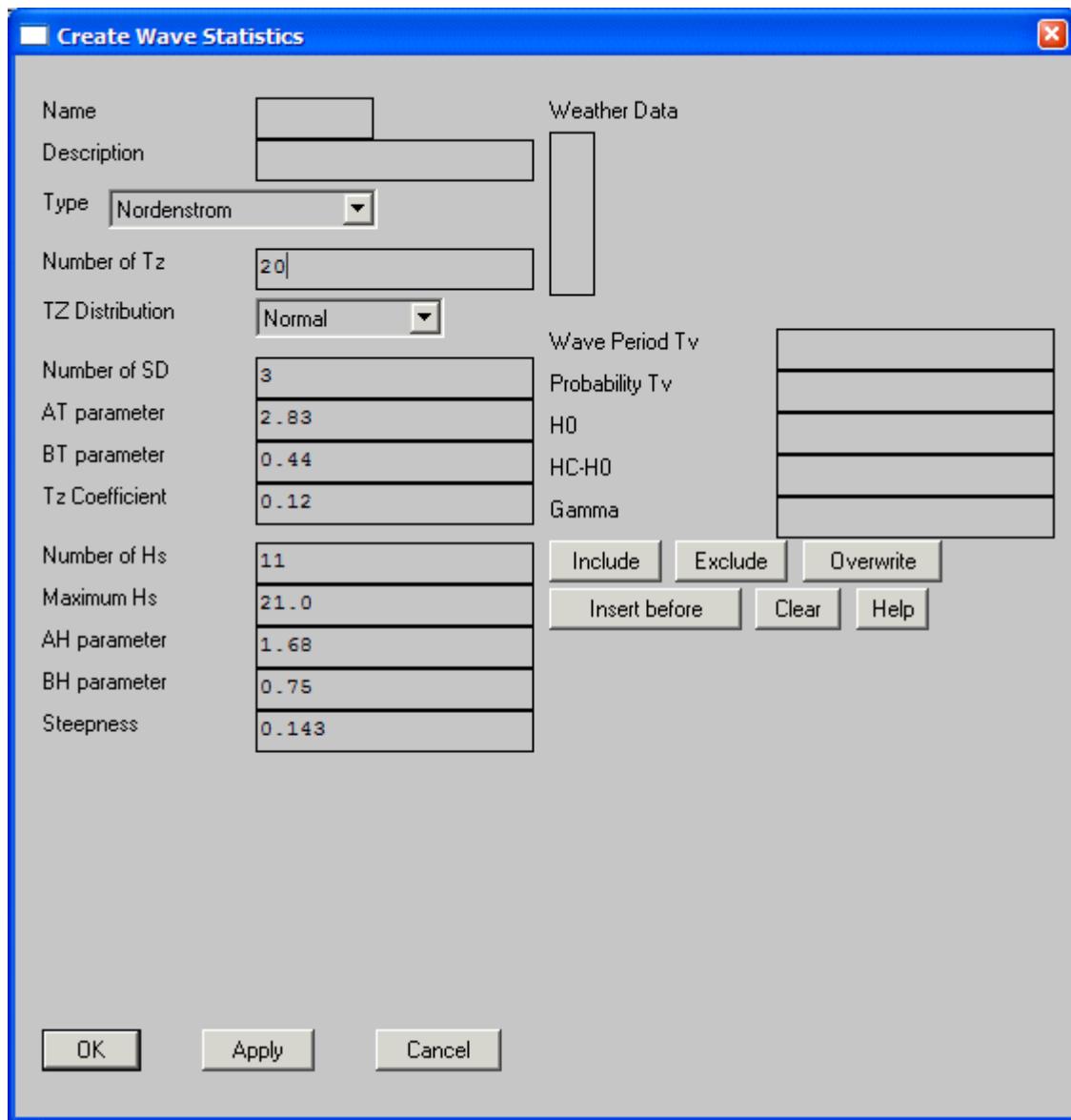
Figure C.26   CREATE: WAVE-STATISTICS (Nordenstrom)
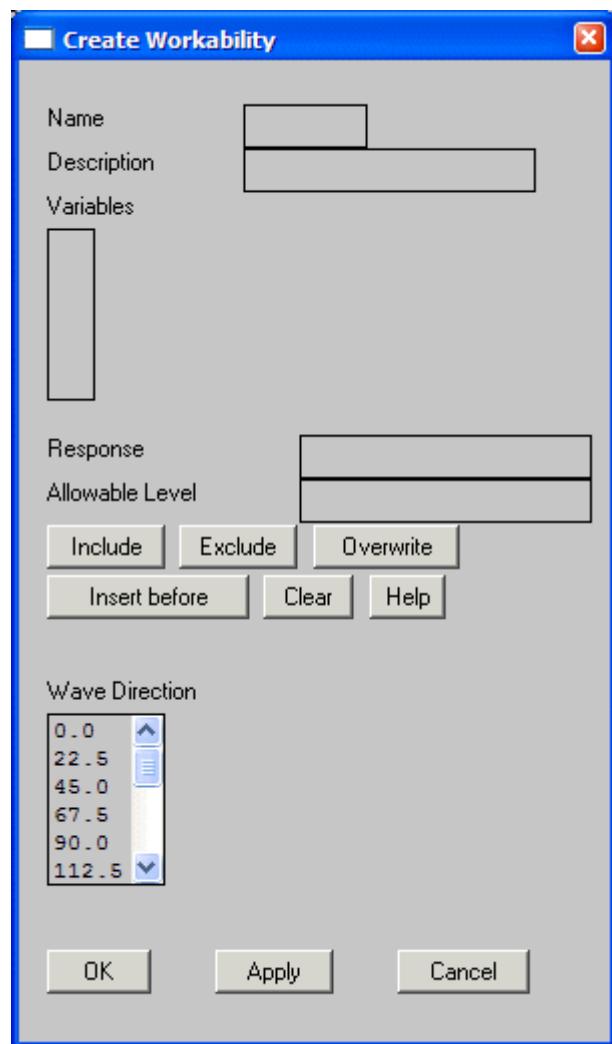
Figure C.27   CREATE: WORKABILITY

C 6   DEFINE Menu
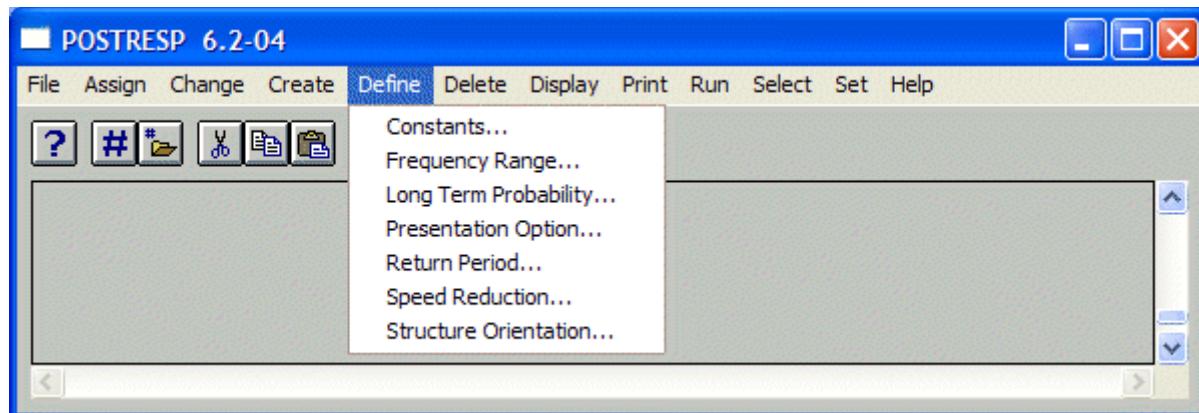
Figure C.28   DEFINE pulldown menu
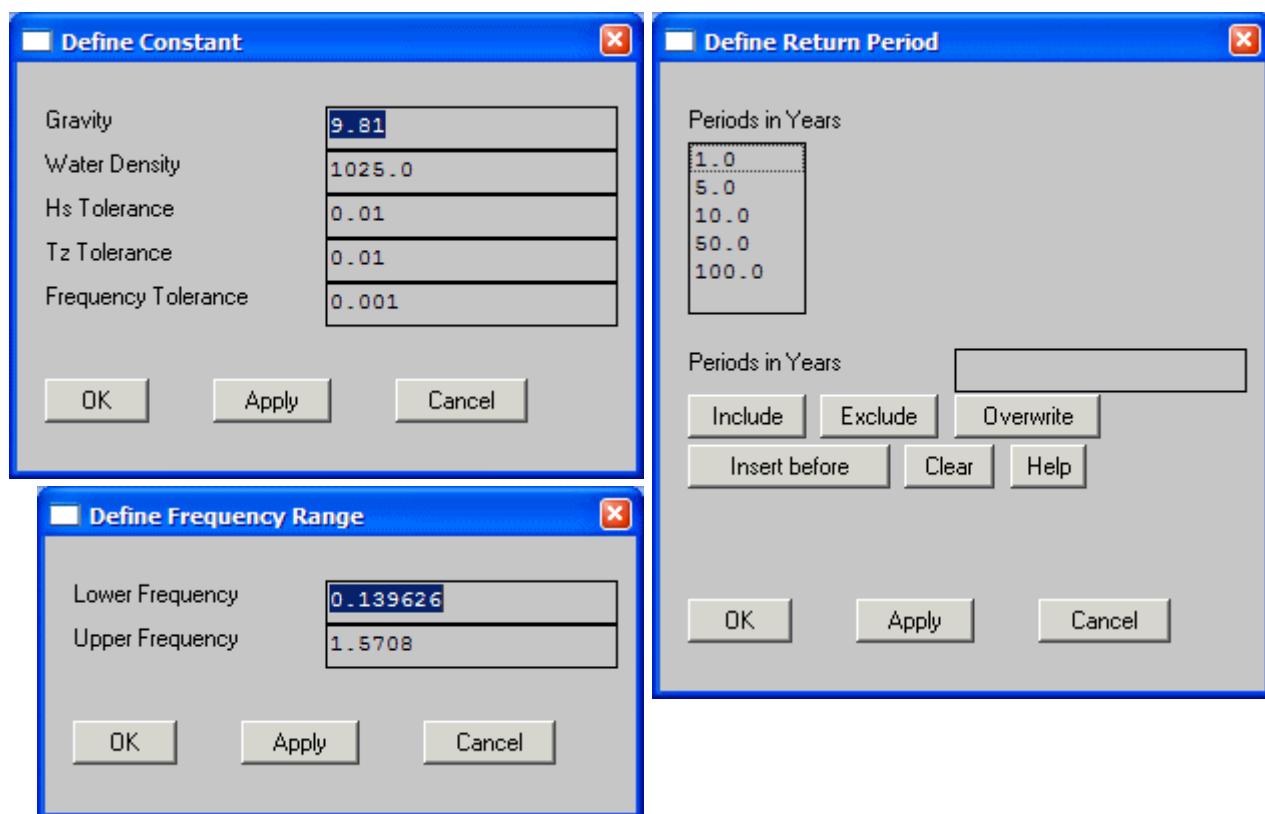
Figure C.29   DEFINE: CONSTANTS, FREQUENCY-RANGE, RETURN-PERIOD
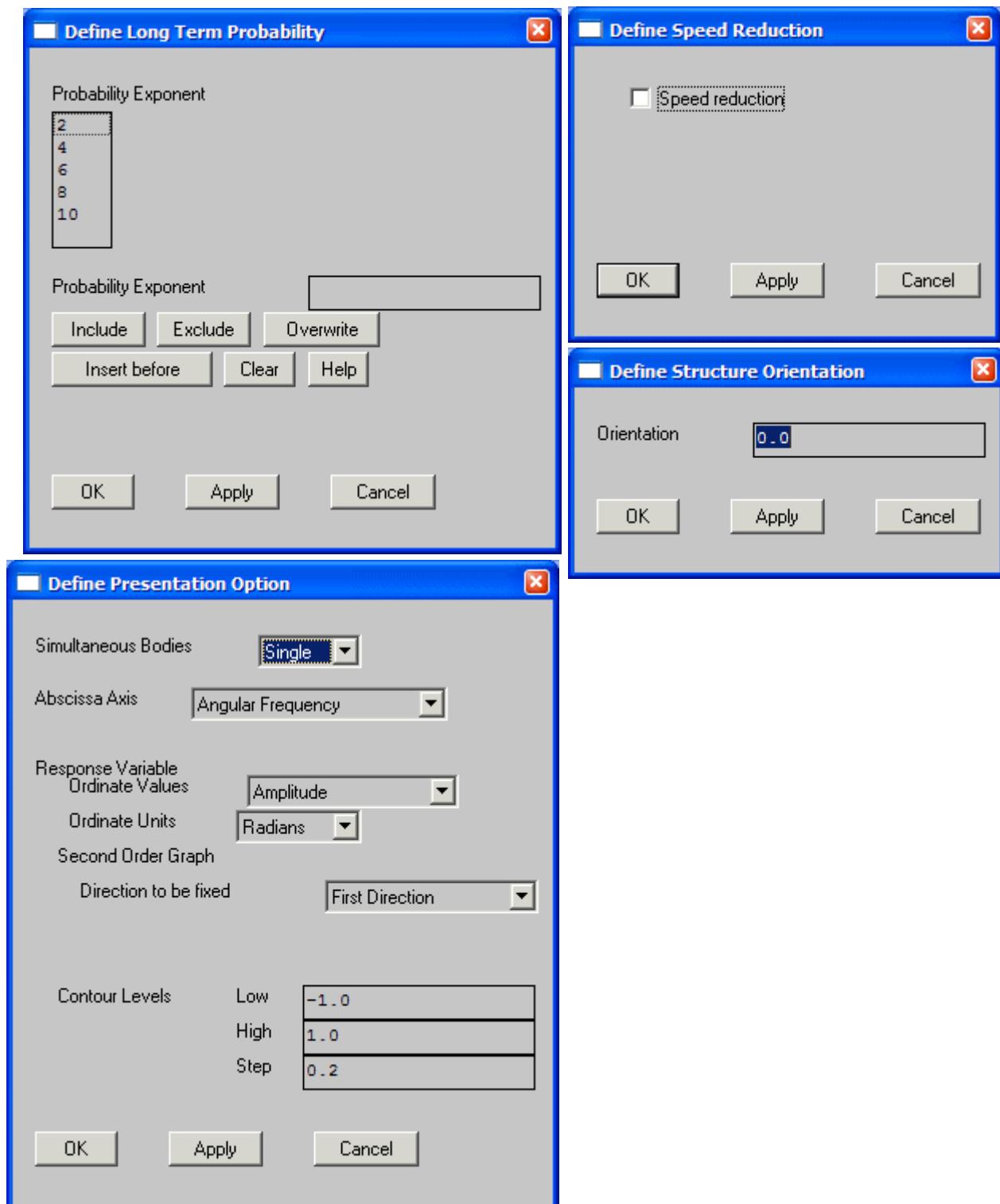
Figure C.30   DEFINE: LONG-TERM-PROBABILITY, PRESENTATION-OPTION, SPEED-REDUCTION, STRUCTURE-ORIENTATION

C 7   DELETE Menu
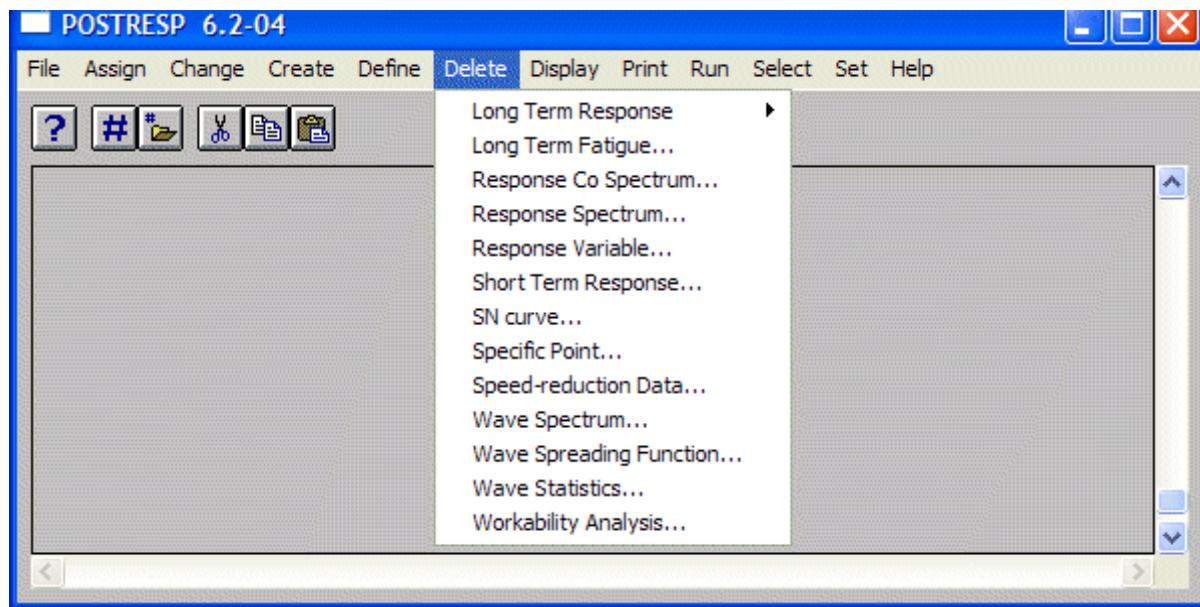
Figure C.31   DELETE pulldown menu
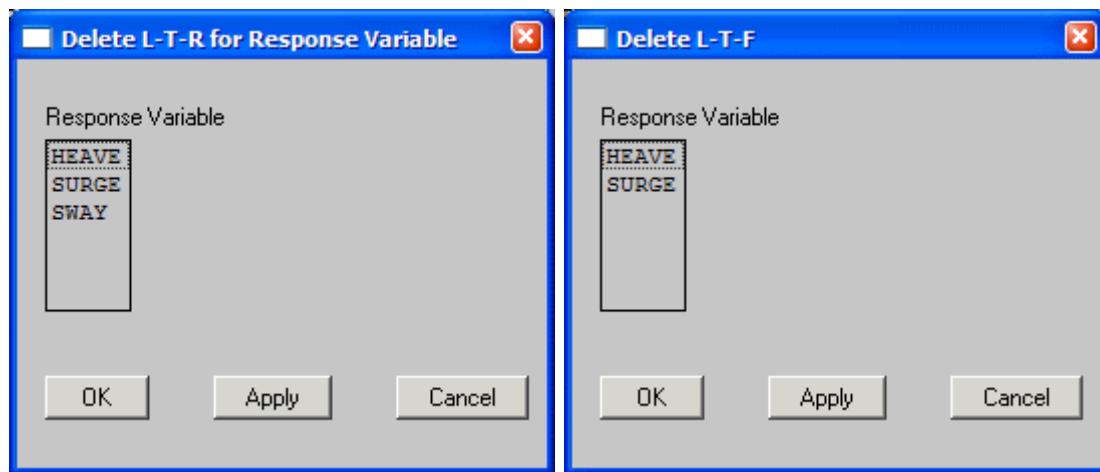
Figure C.32   DELETE: LONG-TERM-RESPONSE RESPONSE-VARIABLE, LONG-TERM-FATIGUE
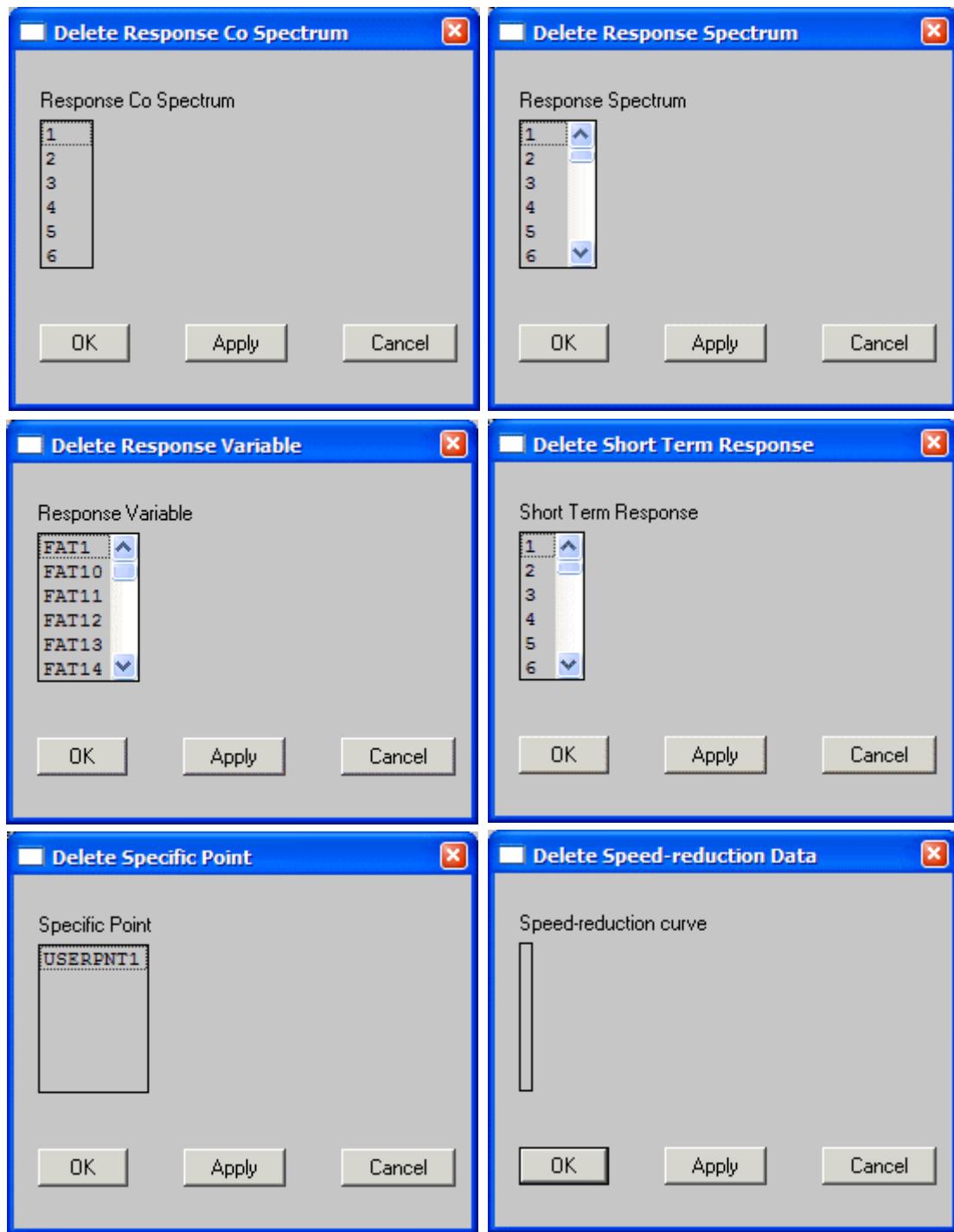
Figure C.33   DELETE: RESPONSE-CO-SPECTRUM, RESPONSE-SPECTRUM, RESPONSE-VARIABLE, SHORT-TERM-RESPONSE, SPECIFIC-POINT, SPEED-REDUCTION-DATA
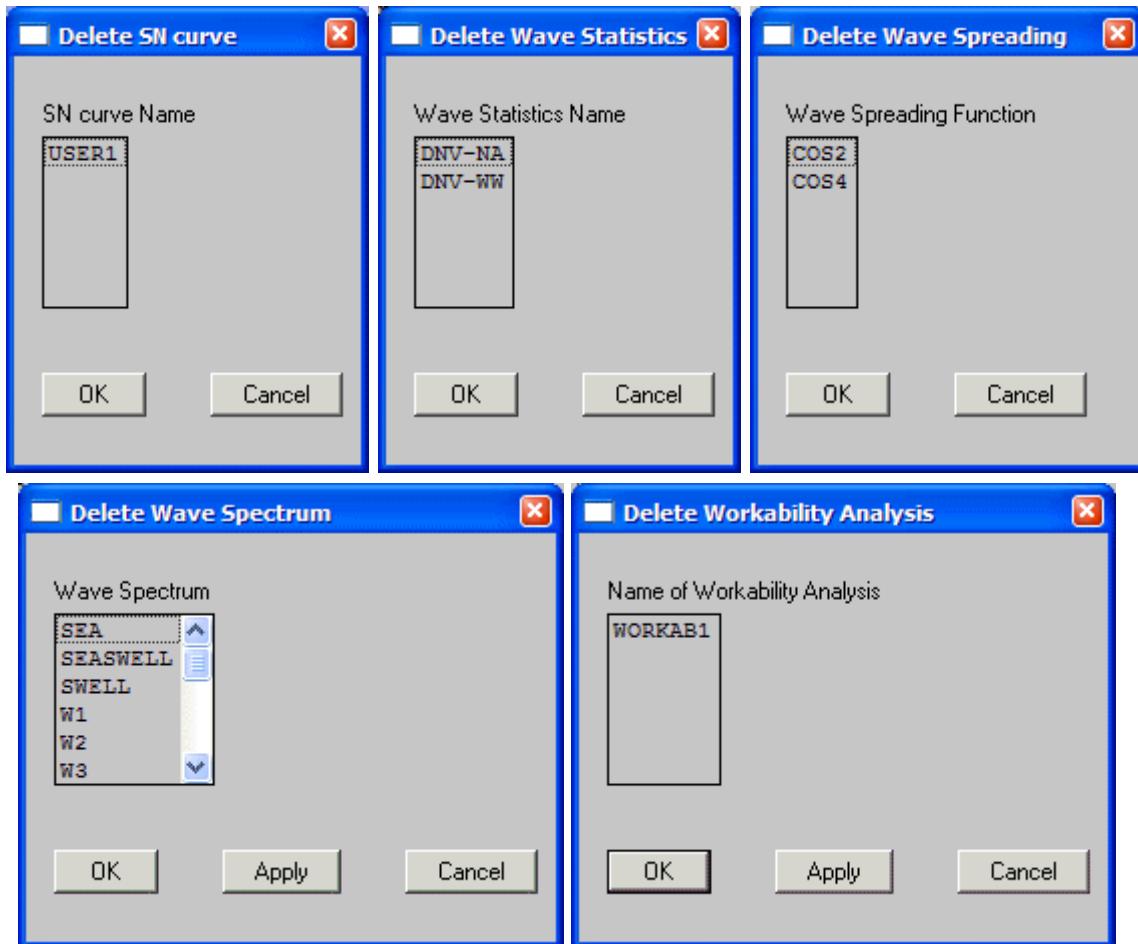
Figure C.34   DELETE: SN-CURVE, WAVE-STATISTICS, WAVE-SPREADING-FUNCTION, WAVE-SPECTRUM, WORKABILITY-ANALYSIS

C 8   DISPLAY Menu
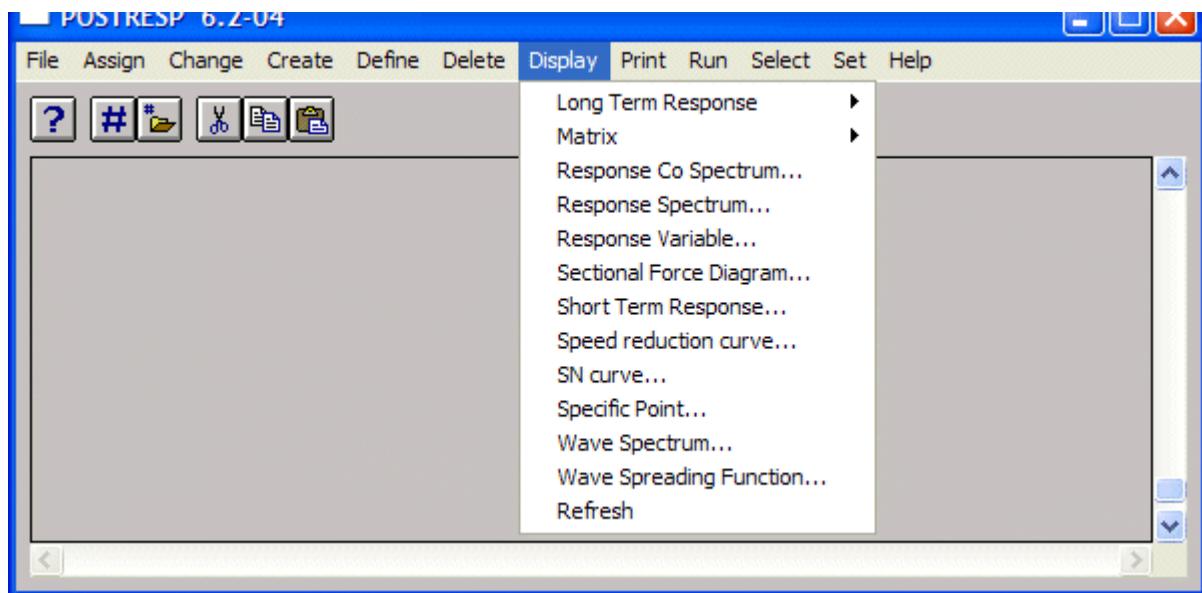
Figure C.35   DISPLAY pulldown menu
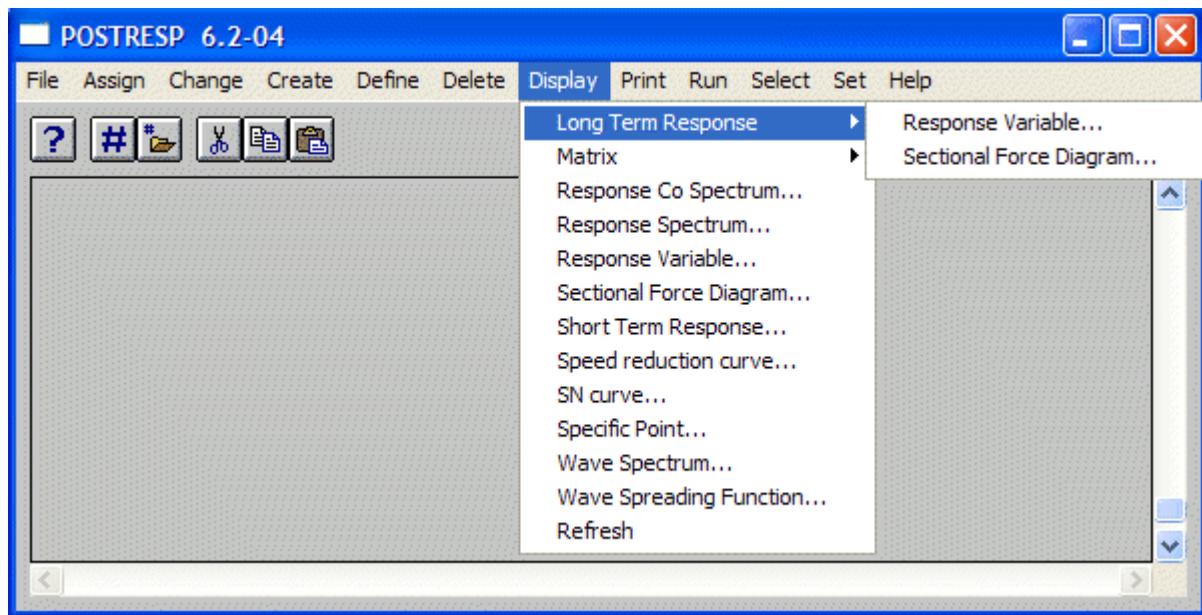
Figure C.36   DISPLAY LONG-TERM-RESPONSE pulldown menu
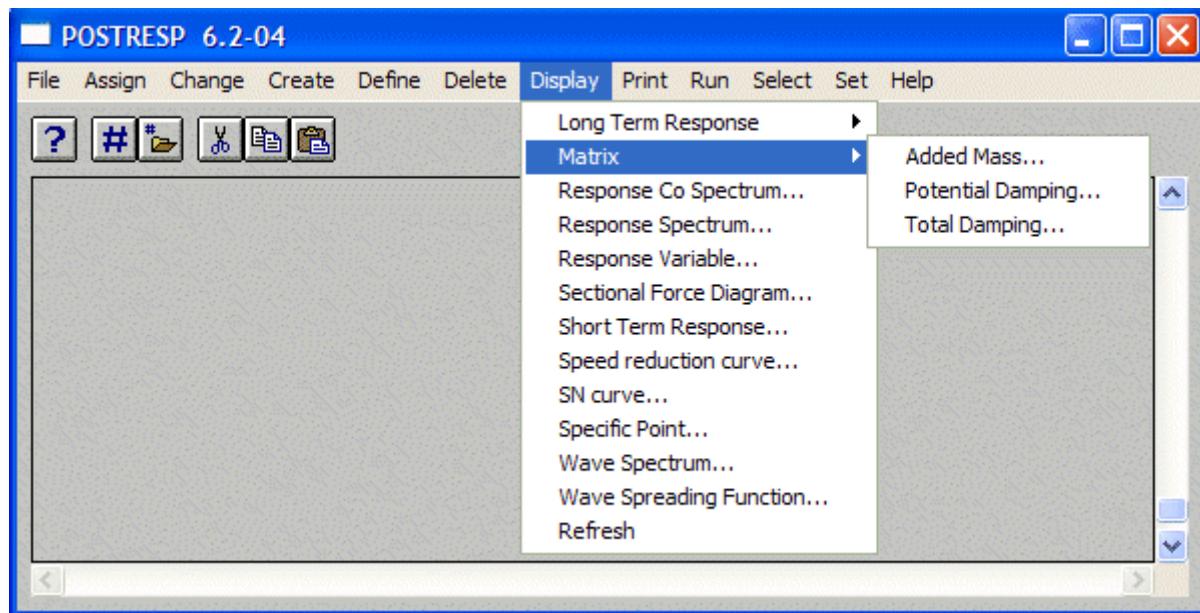
Figure C.37   DISPLAY MATRIX pulldown menu
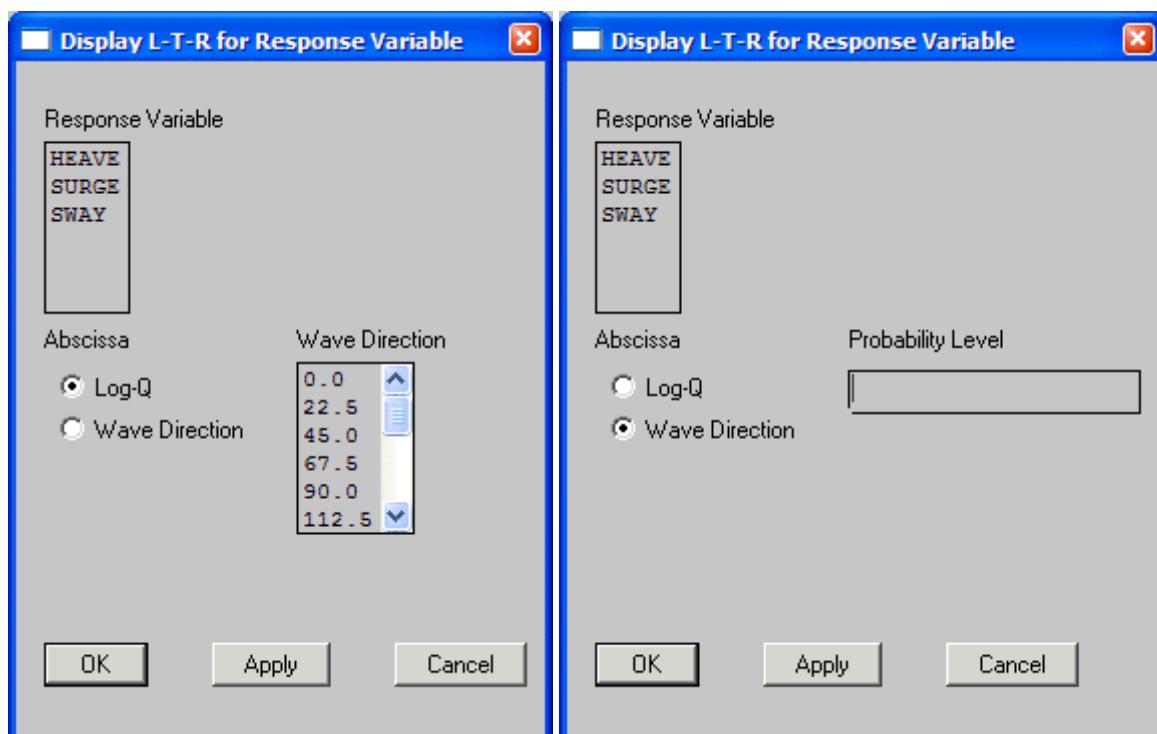
Figure C.38   DISPLAY: LONG-TERM-RESPONSE RESPONSE-VARIABLE
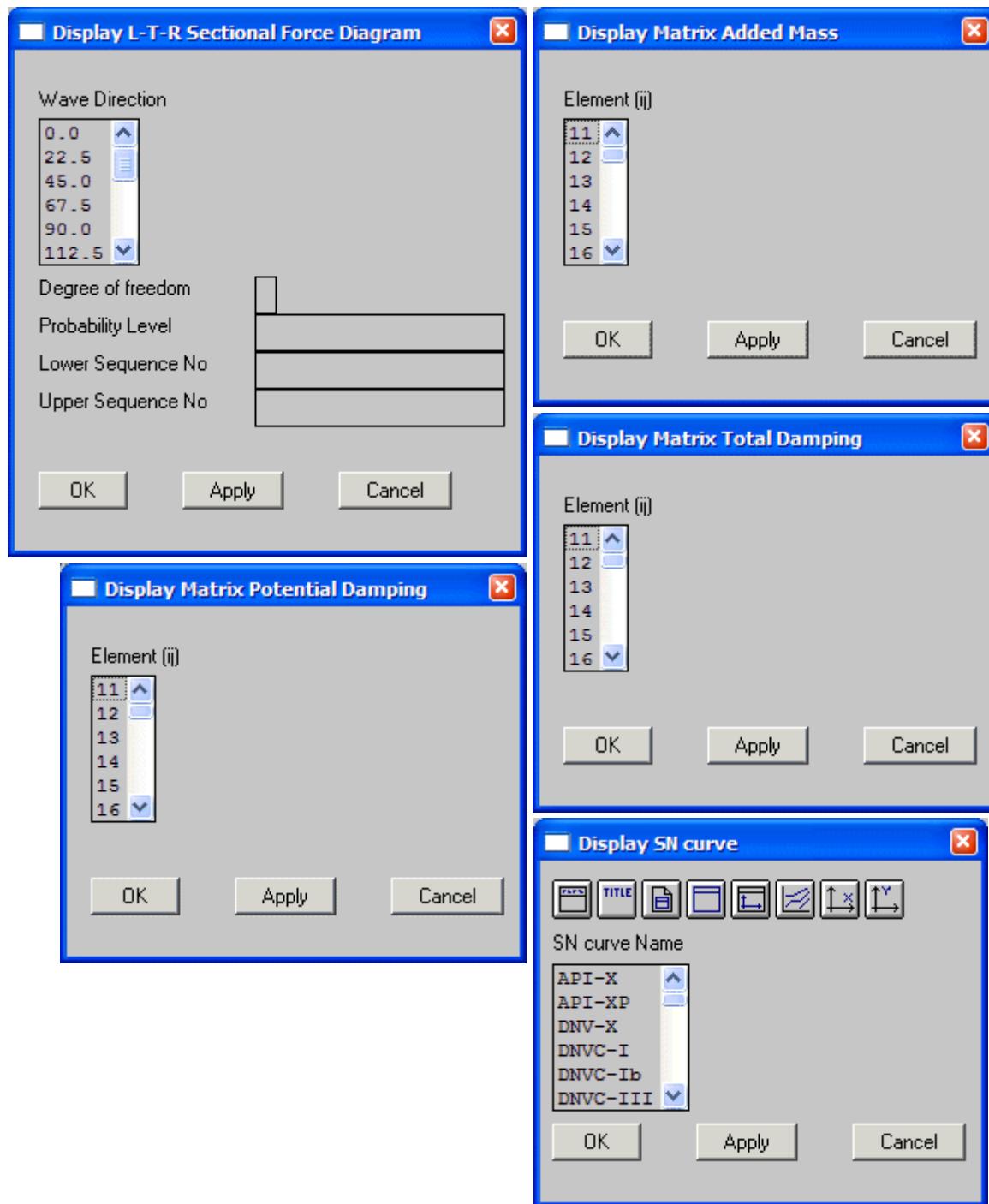
Figure C.39   DISPLAY: LONG-TERM-RESPONSE SECTIONAL-FORCE-DIAGRAM, MATRIX ADDED-MASS, MATRIX POTENTIAL-DAMPING, MATRIX TOTAL-DAMPING. SN-CURVE
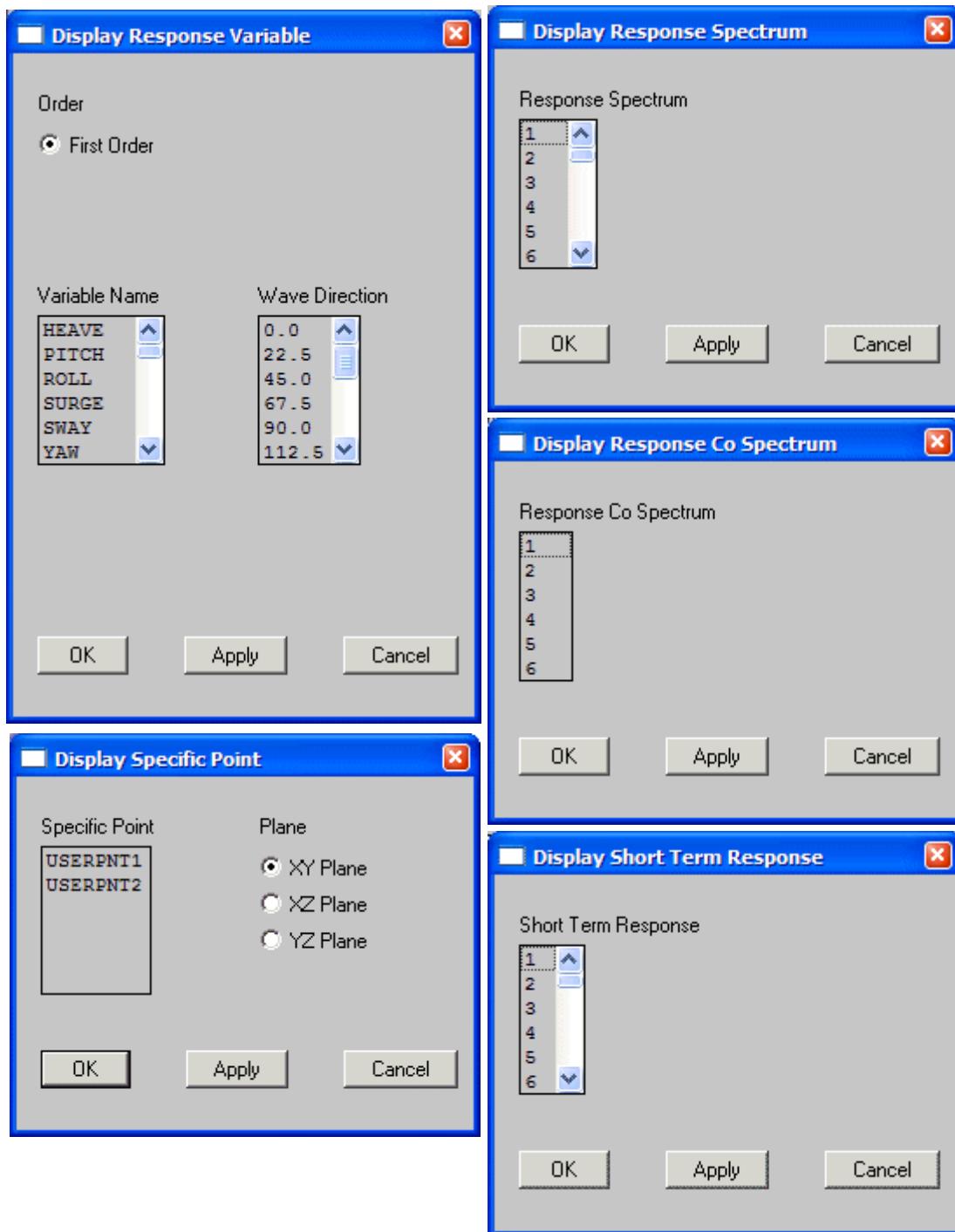
**Figure C.40   DISPLAY: RESPONSE-VARIABLE, RESPONSE-SPECTRUM, RESPONSE-CO-
SPECTRUM, SPECIFIC-POINT, SHORT-TERM-RESPONSE**
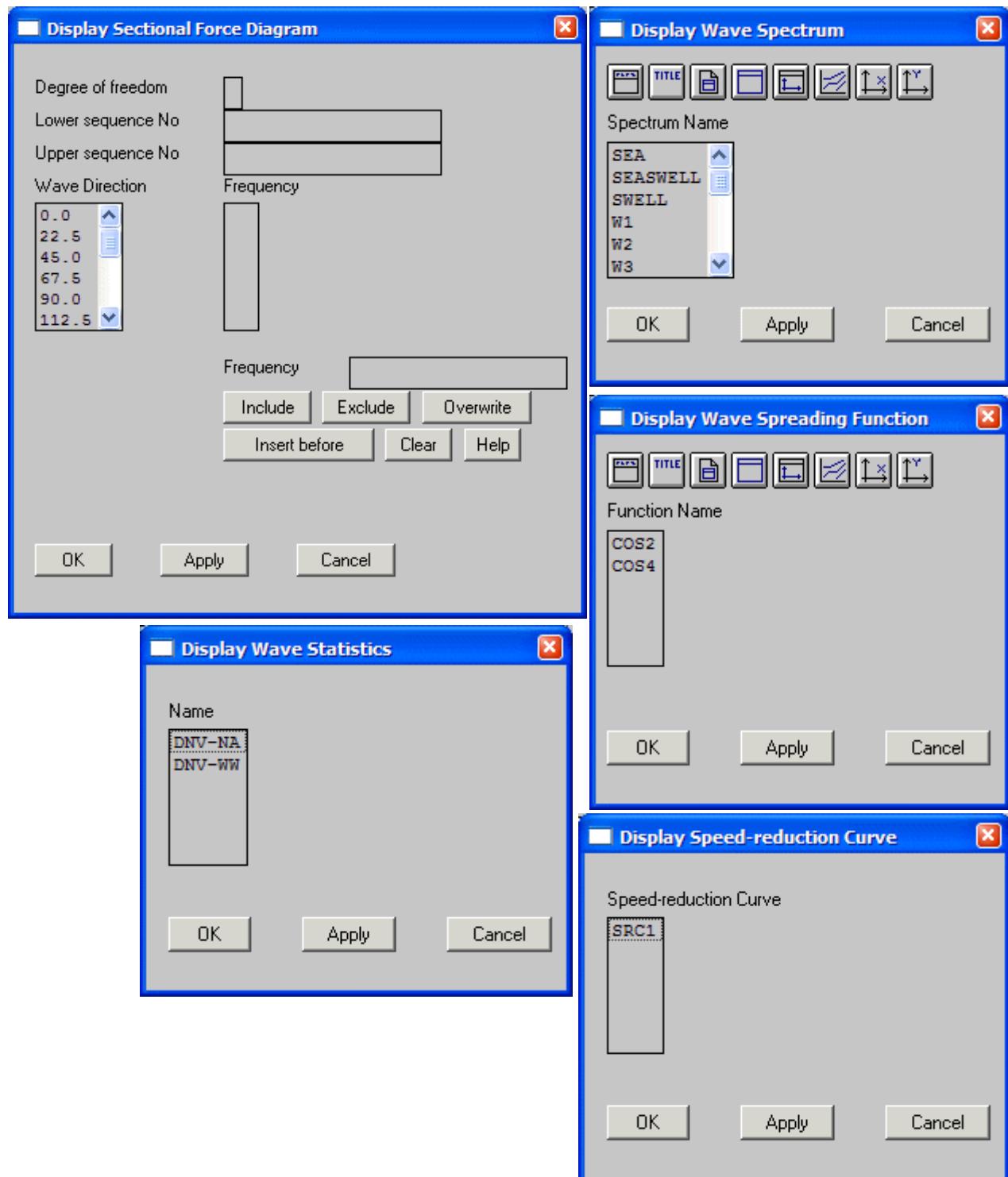
Figure C.41   DISPLAY: SECTIONAL-FORCE-DIAGRAM, SPEED-REDUCTION-CURVE, WAVE-SPECTRUM, WAVE-SPREADING-FUNCTION, WAVE-STATISTICS

C 9   PRINT Menu
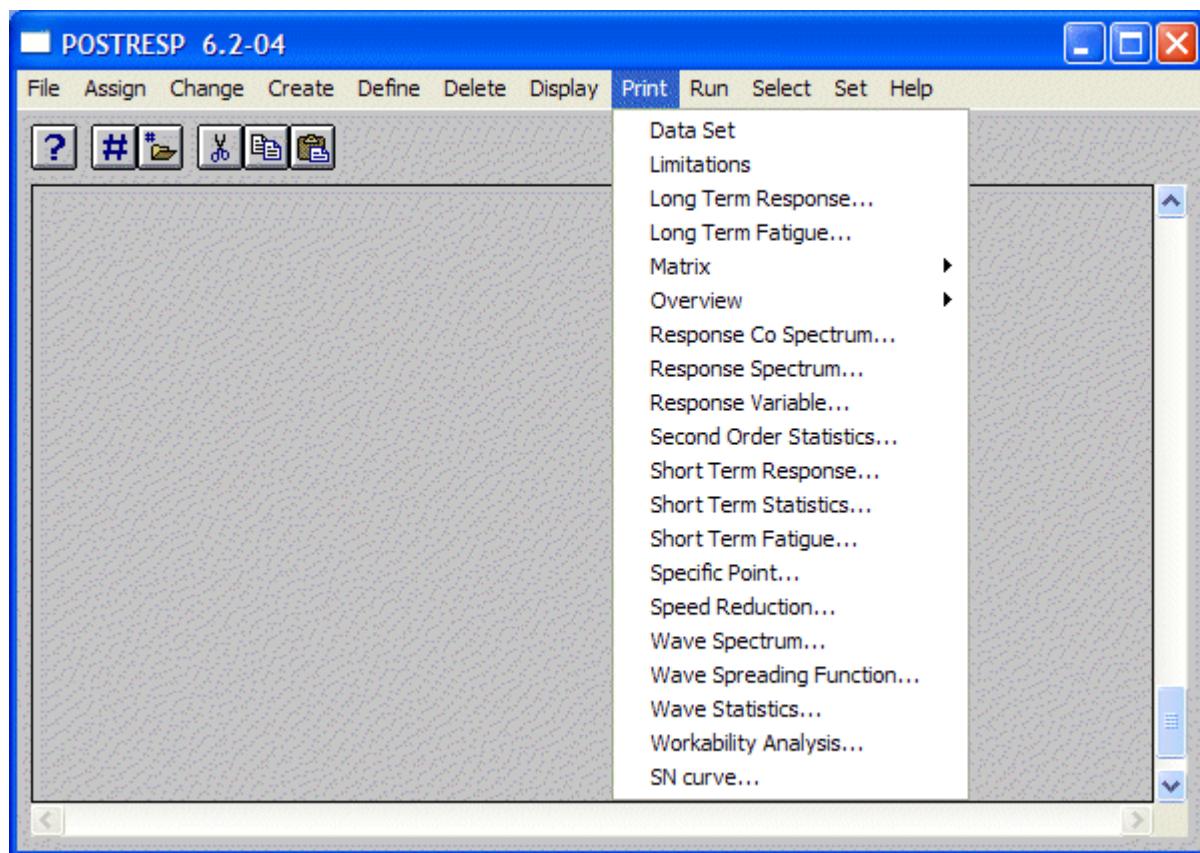
Figure C.42   PRINT pull down menu
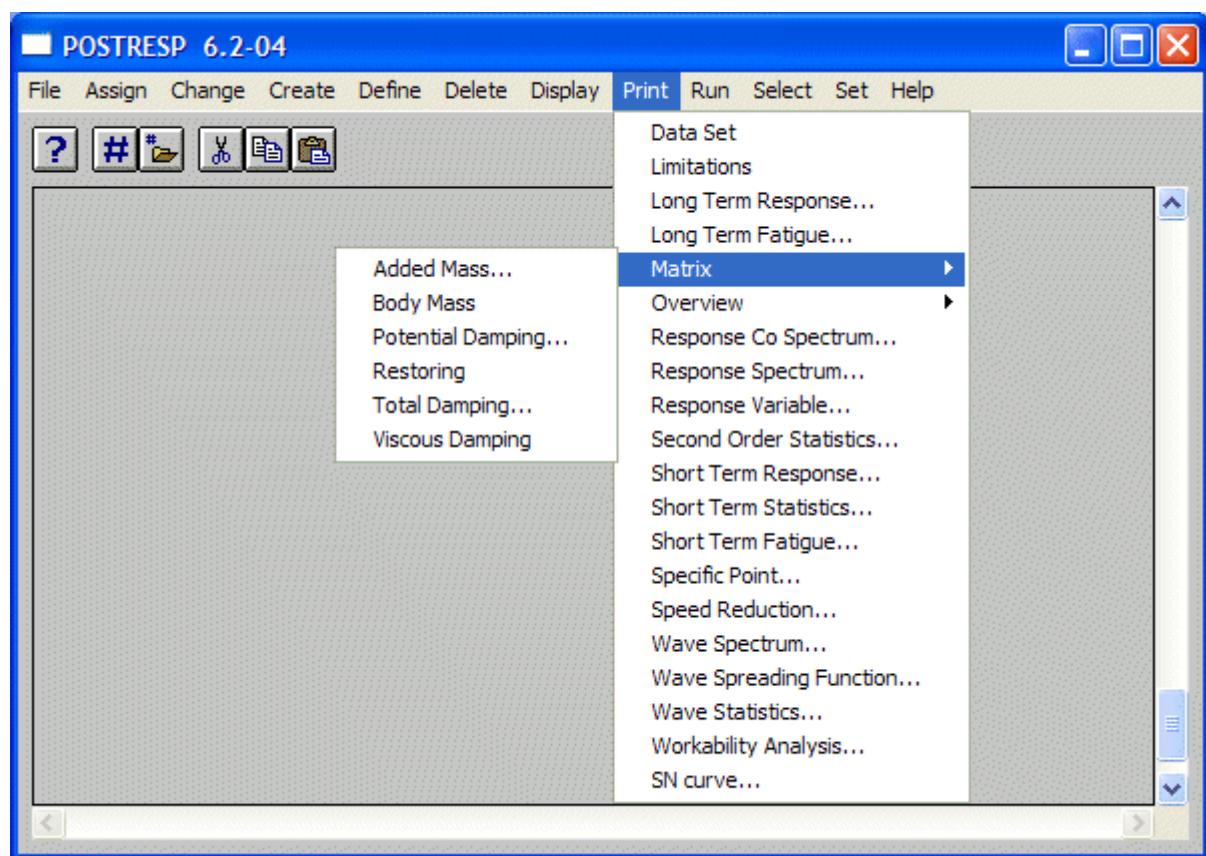
Figure C.43   PRINT MATRIX pull down menu
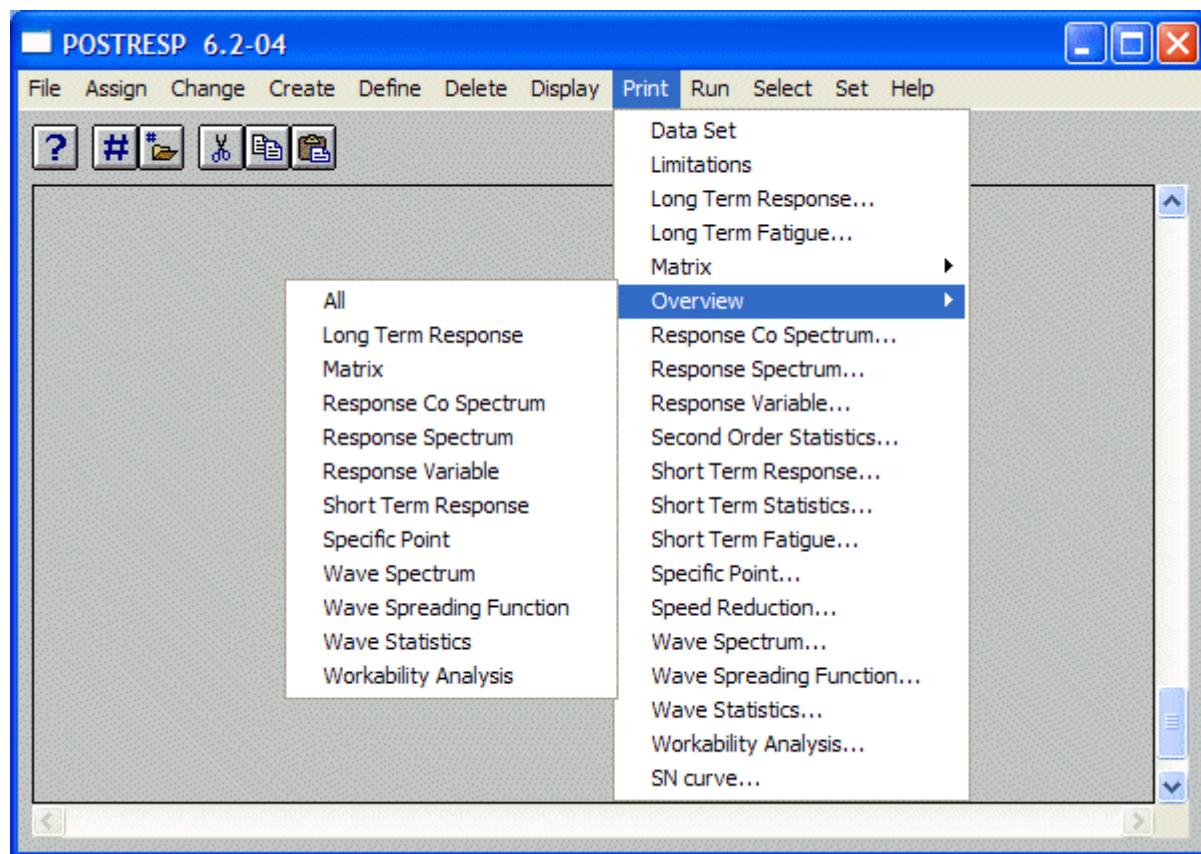
Figure C.44   PRINT OVERVIEW pull down menu
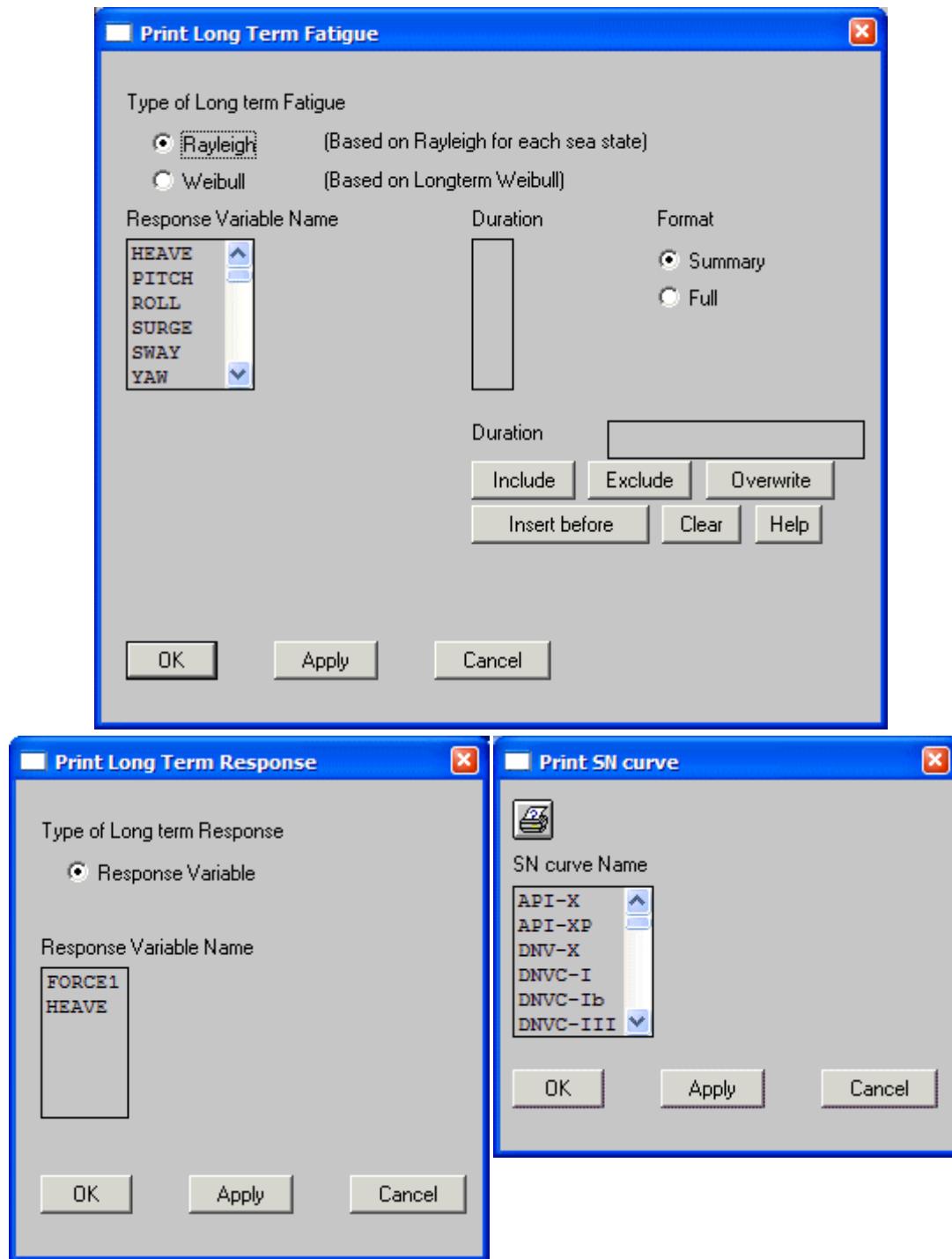
Figure C.45   PRINT: LONG-TERM-FATIGUE (Rayleigh), LONG-TERM-RESPONSE, SN-CURVE
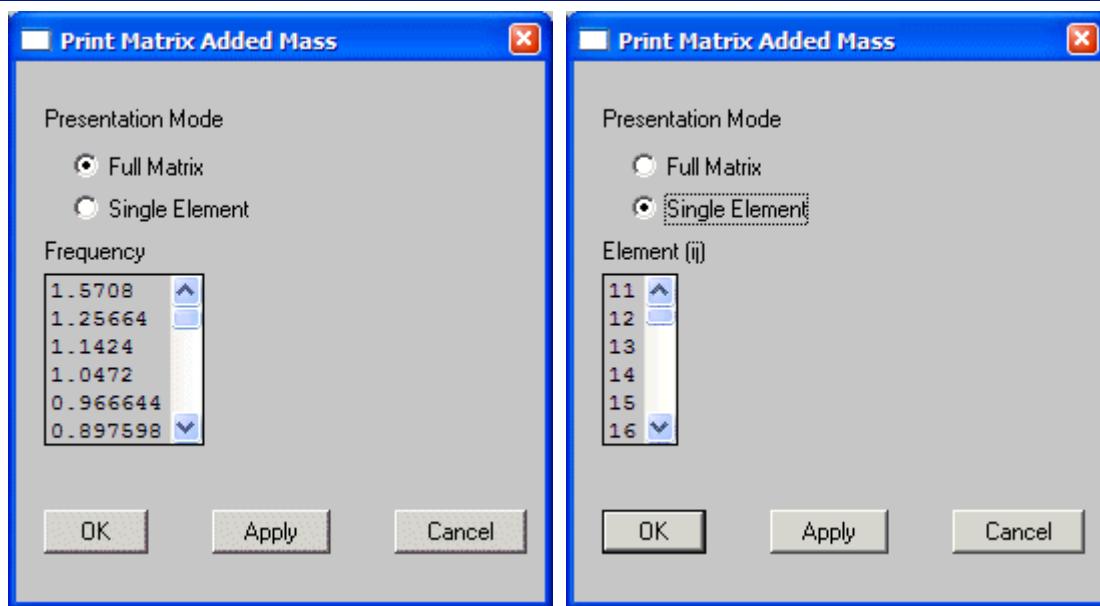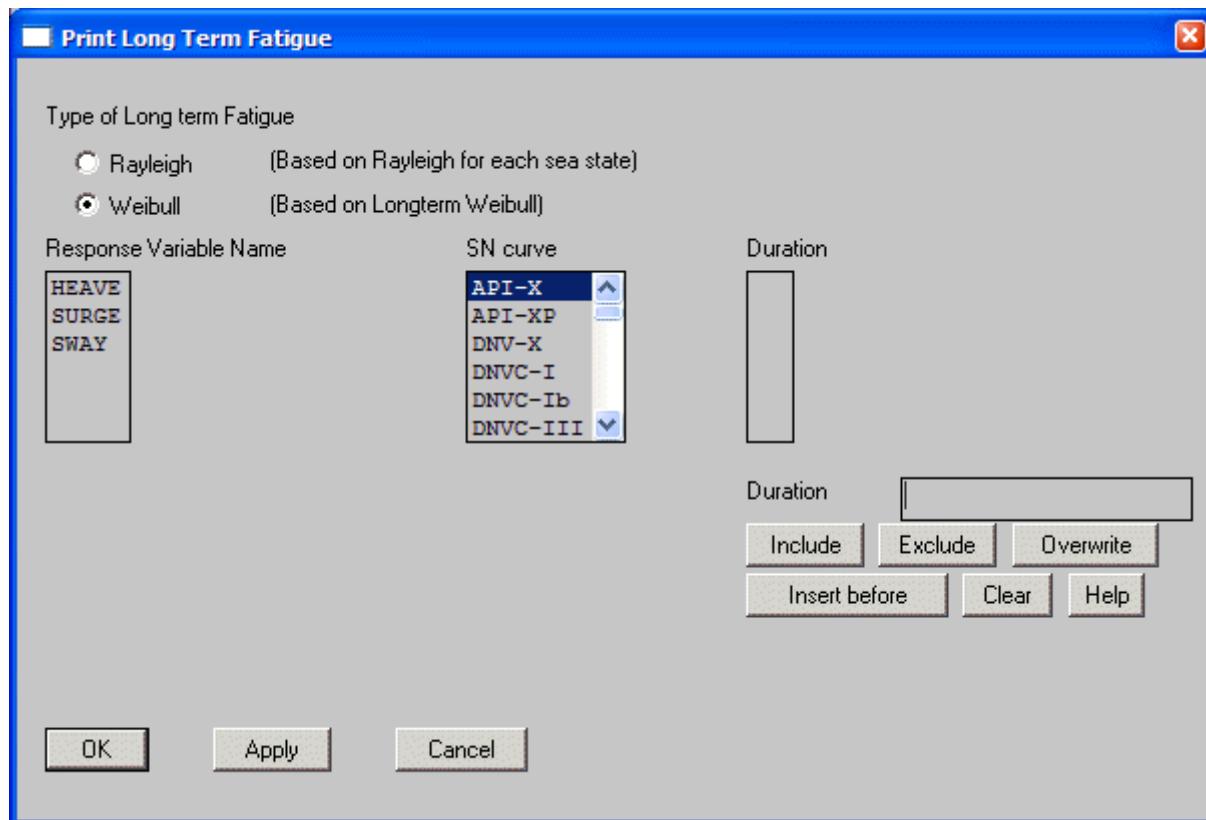
Figure C.46   PRINT: LONG-TERM-FATIGUE (Weibull), MATRIX ADDED-MASS
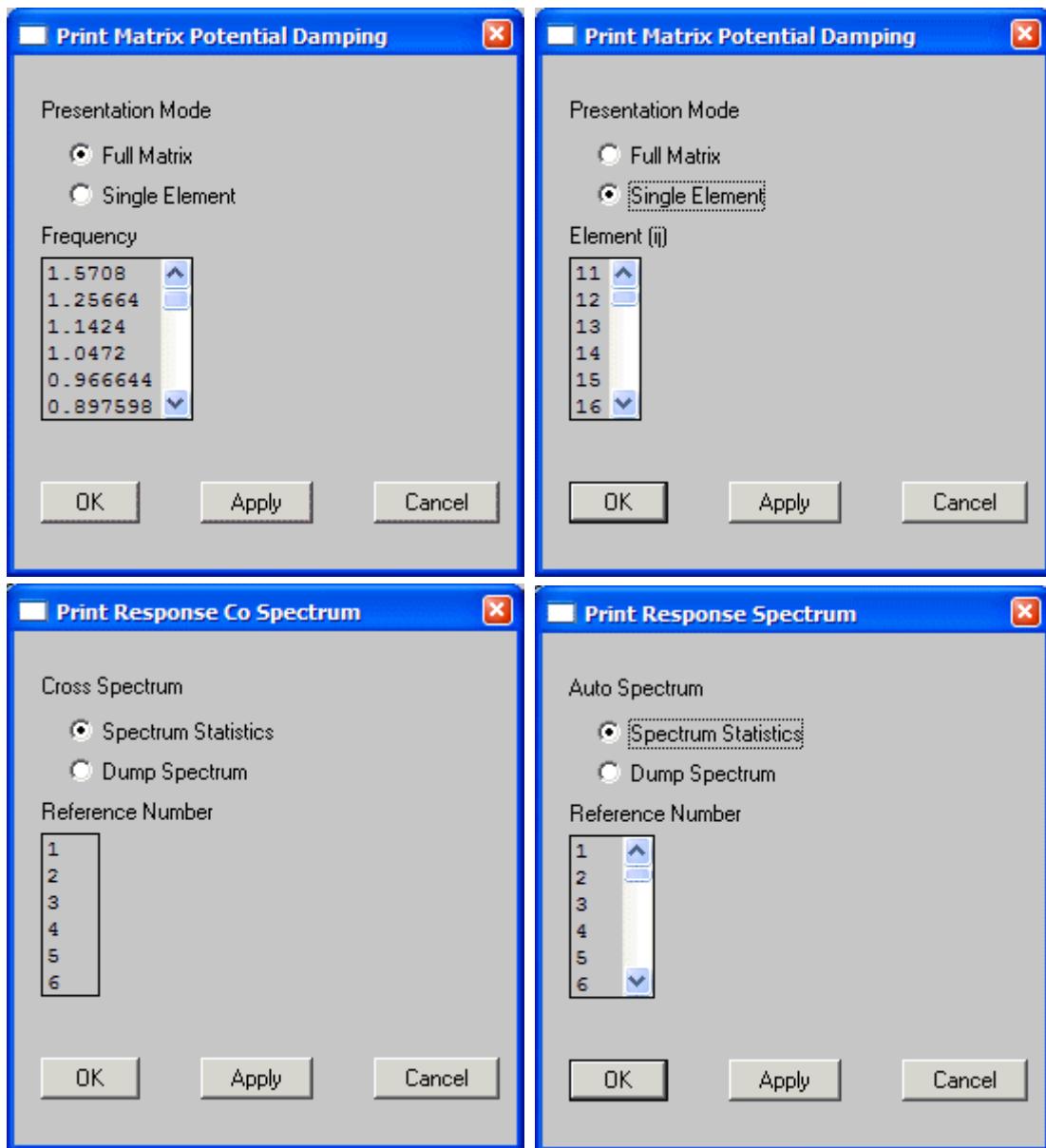
Figure C.47   PRINT: MATRIX POTENTIAL-DAMPING, RESPONSE-CO-SPECTRUM, RESPONSE-SPECTRUM
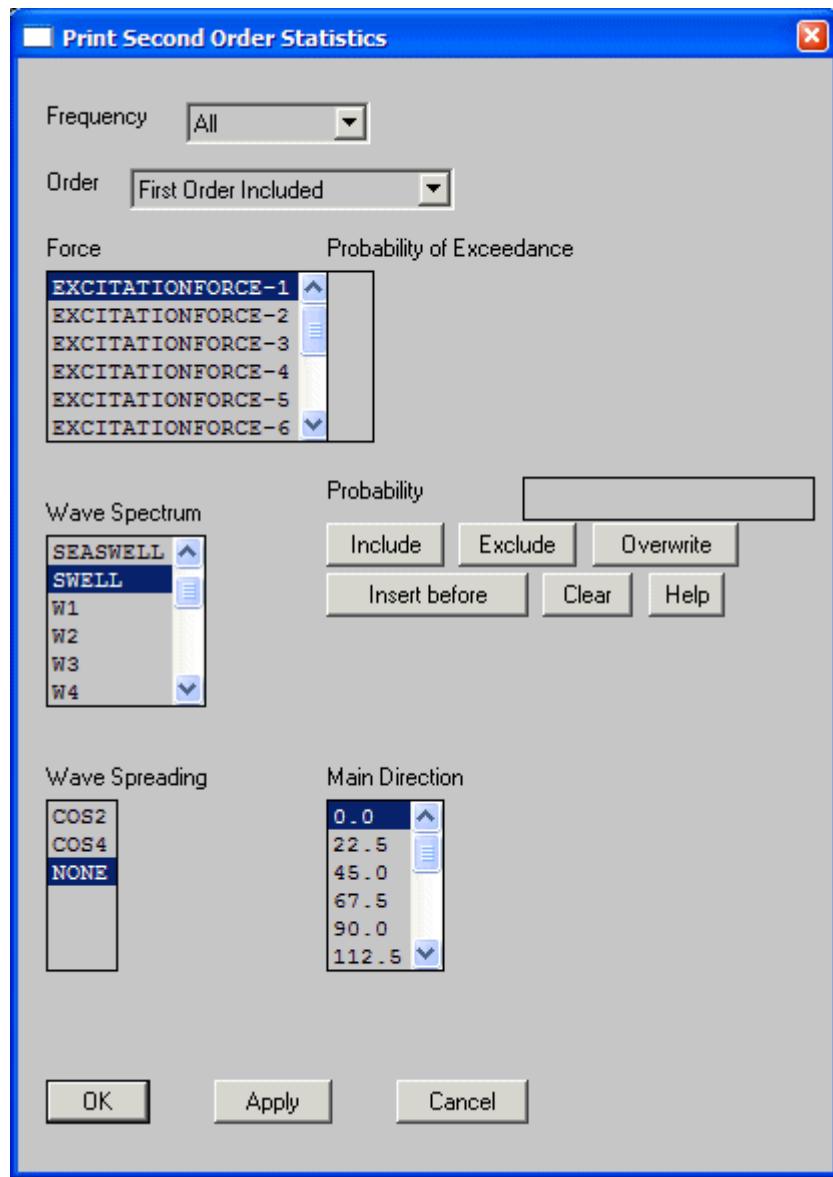
Figure C.48   PRINT SECOND-ORDER-STATISTICS
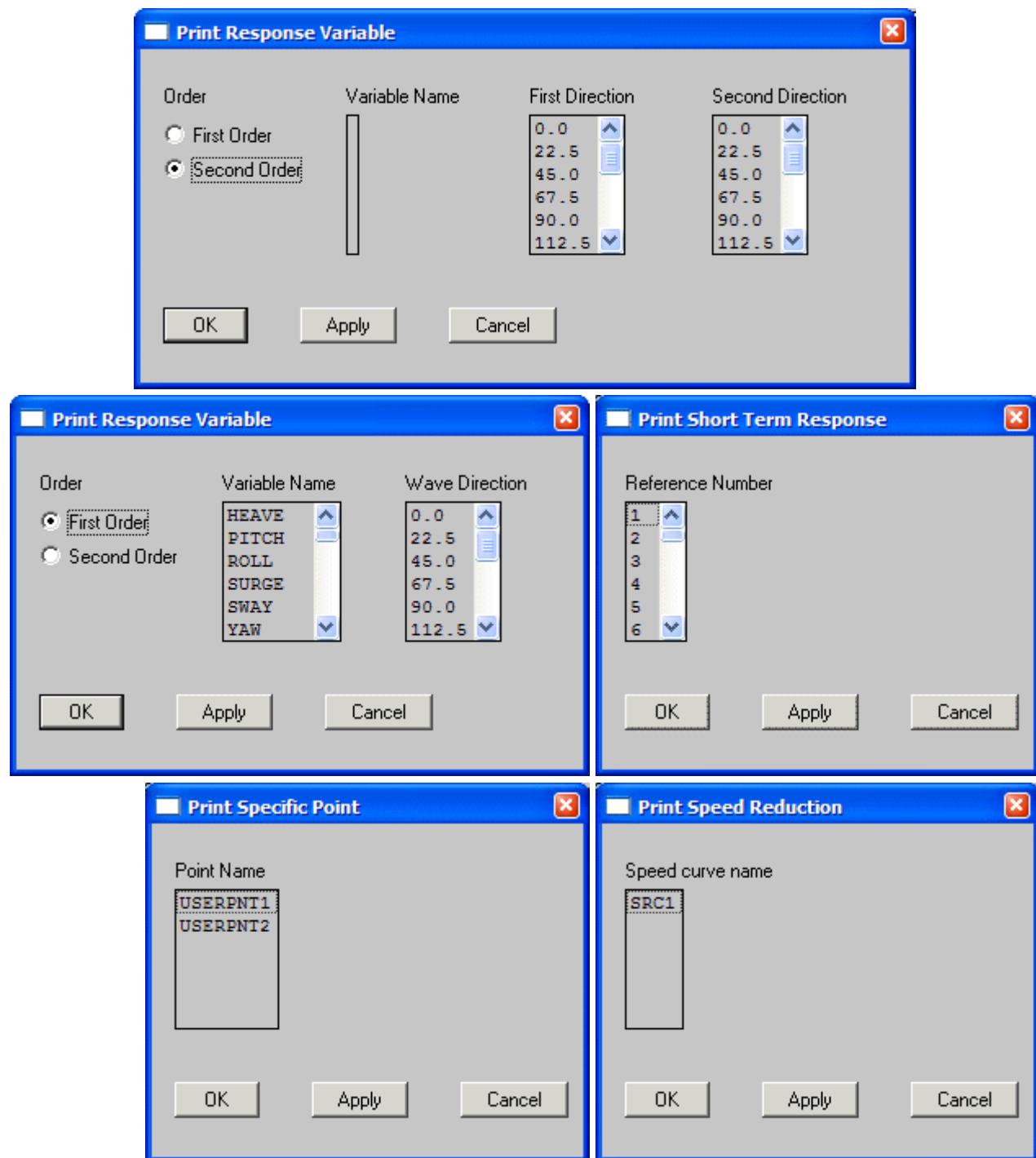
Figure C.49   PRINT: RESPONSE-VARIABLE, SHORT-TERM-RESPONSE, SPECIFIC-POINT, SPEED-REDUCTION
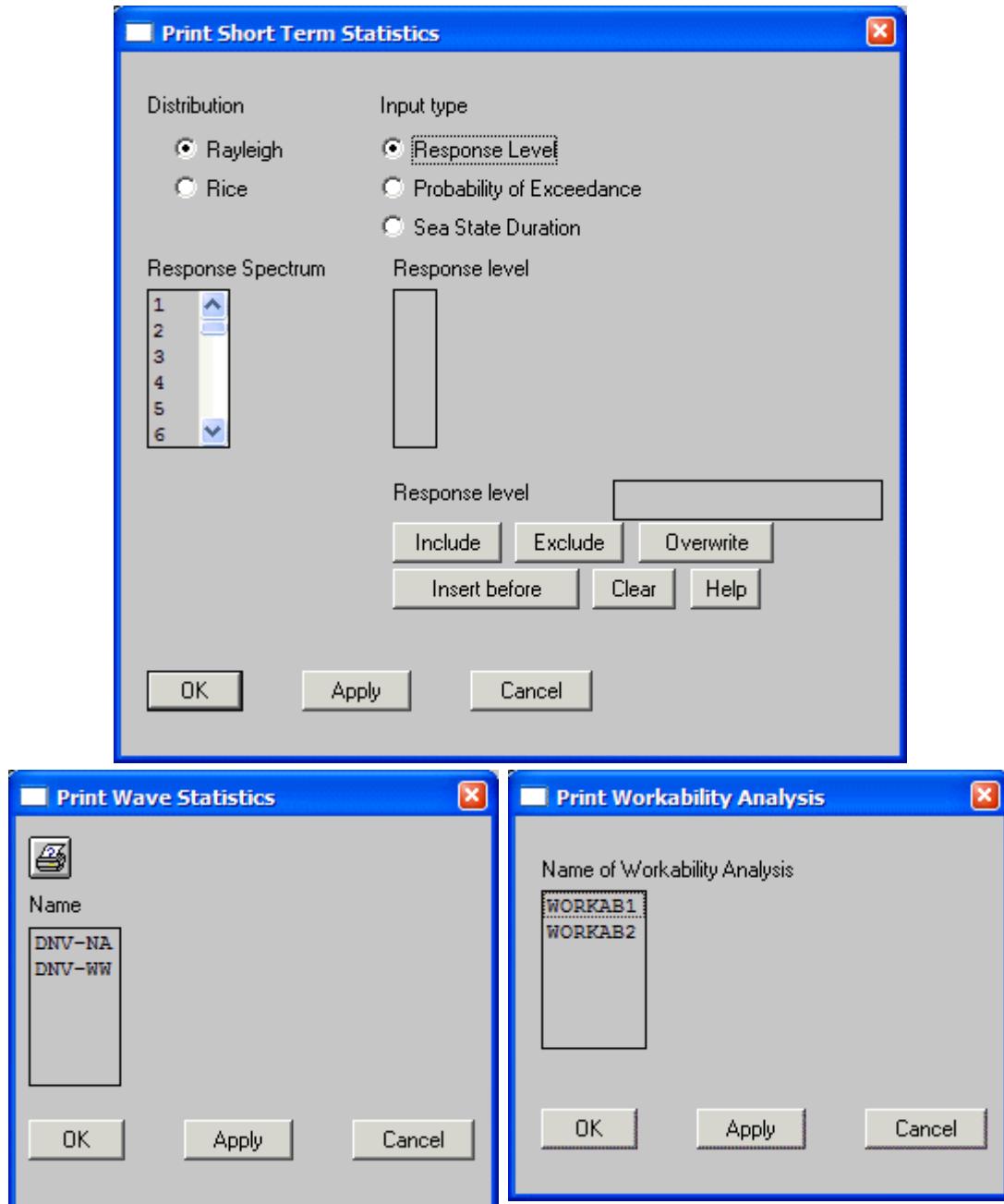
Figure C.50   PRINT: SHORT-TERM-STATISTICS, WAVE-STATISTICS, WORKABILITY-ANAL-YSIS
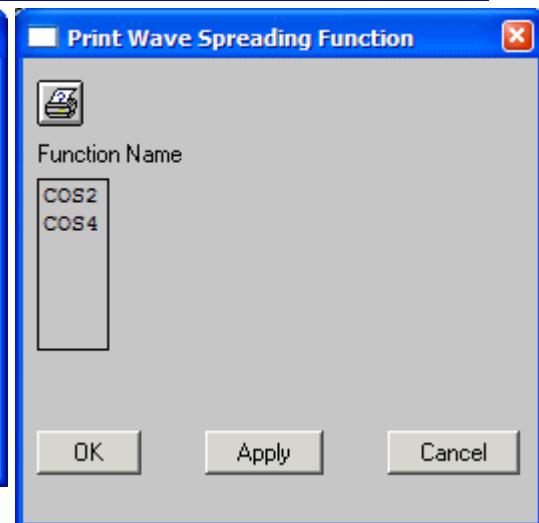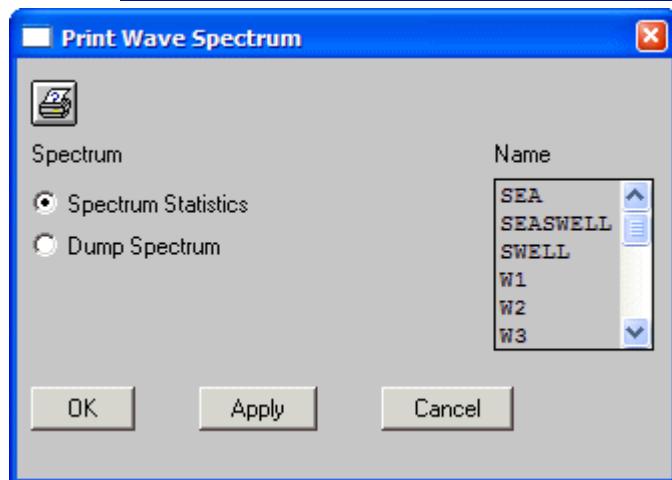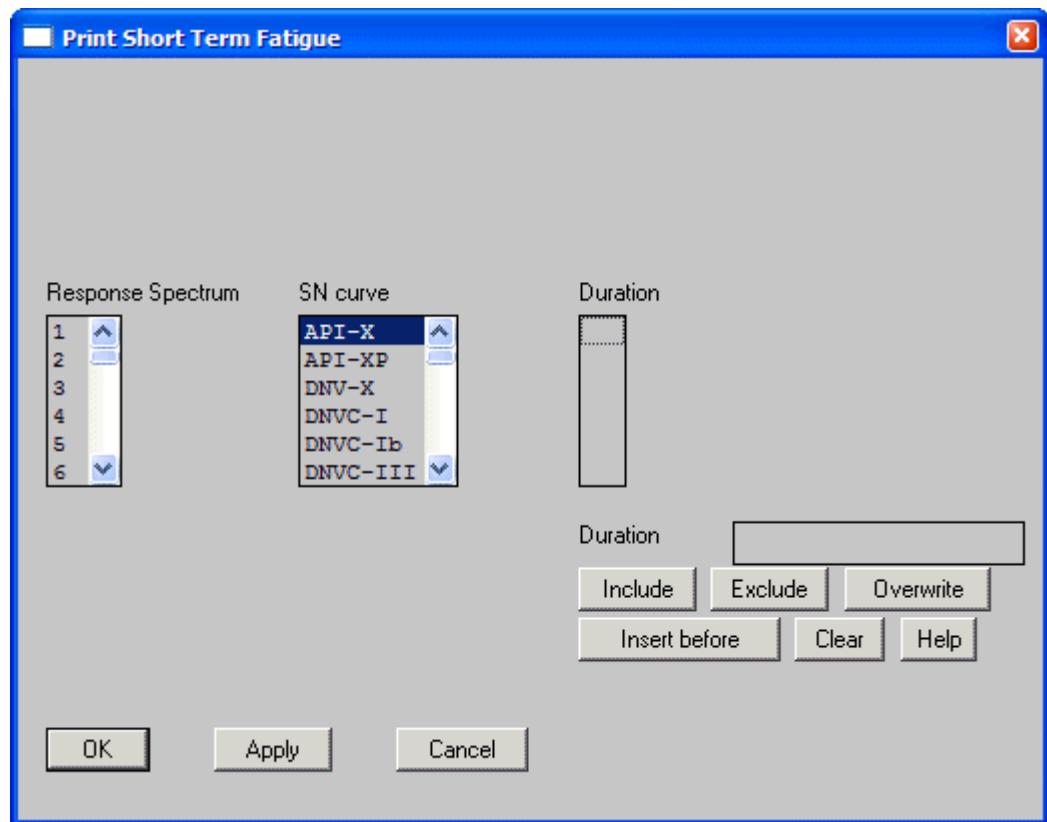
Figure C.51 PRINT: SHORT-TERM-FATIGUE, WAVE-SPECTRUM, WAVE-SPREADING-FUNC-TION

C 10   RUN Menu
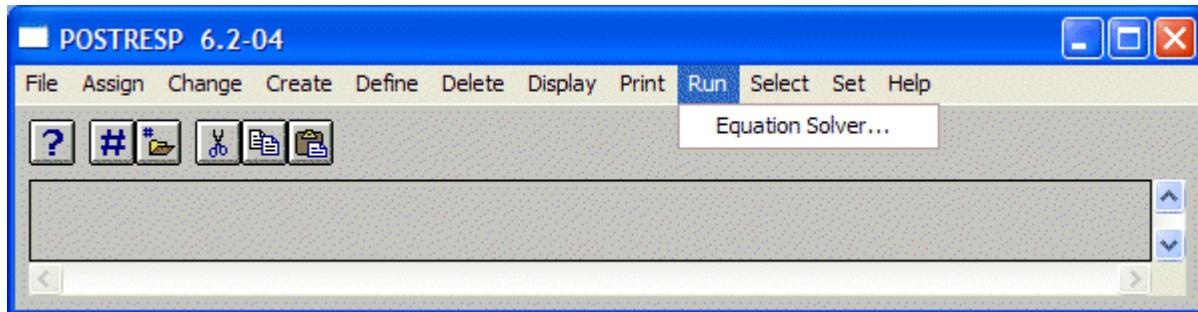
Figure C.52   RUN pulldown menu
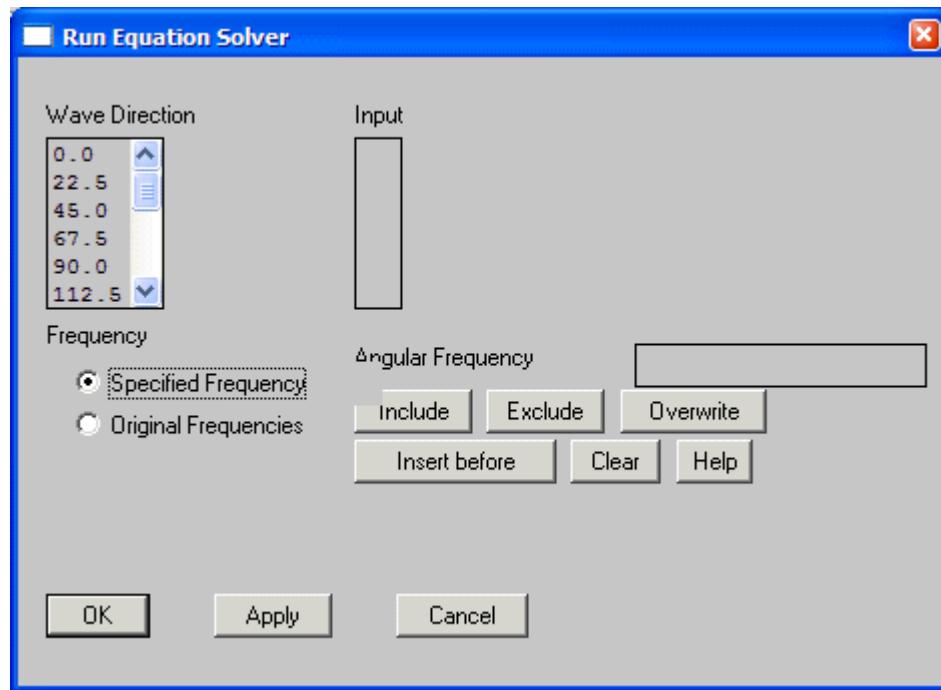
**Figure C.53   RUN EQUATION-SOLVER (Specific Frequency).**
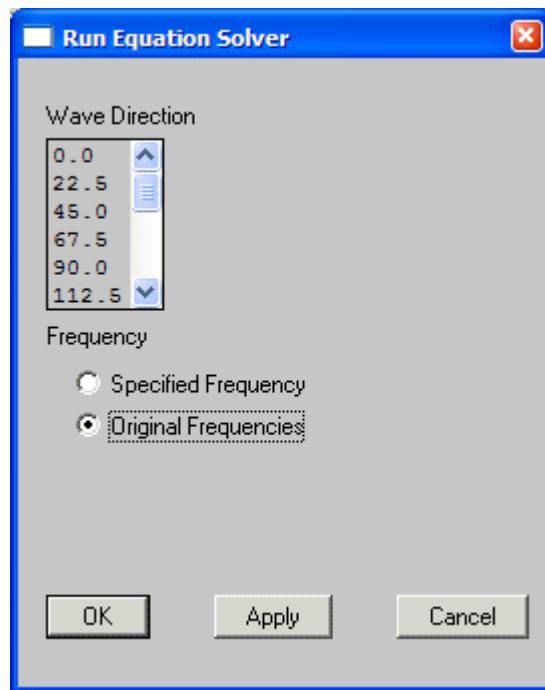
**Figure C.54   RUN EQUATION-SOLVER (Original Frequencies).**

C 11   SELECT Menu
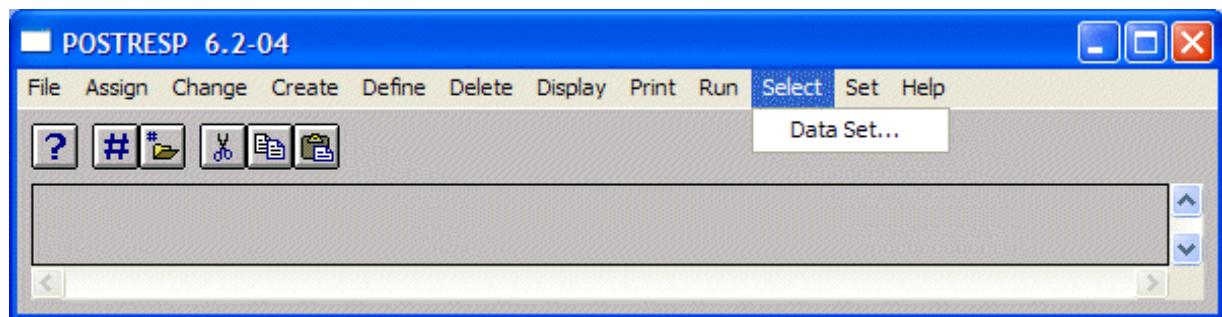

Figure C.55   SELECT pulldown menu
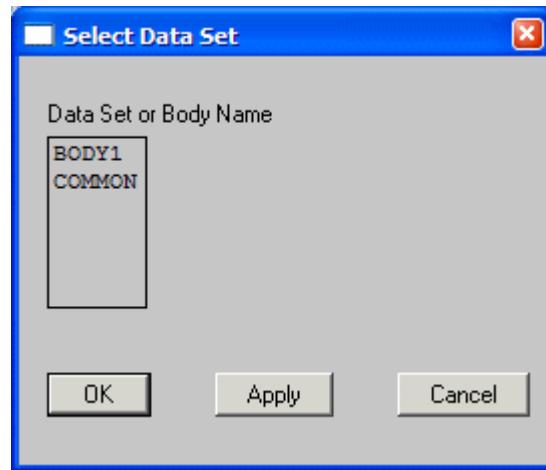
Figure C.56   SELECT DATA-SET

C 12   SET Menu
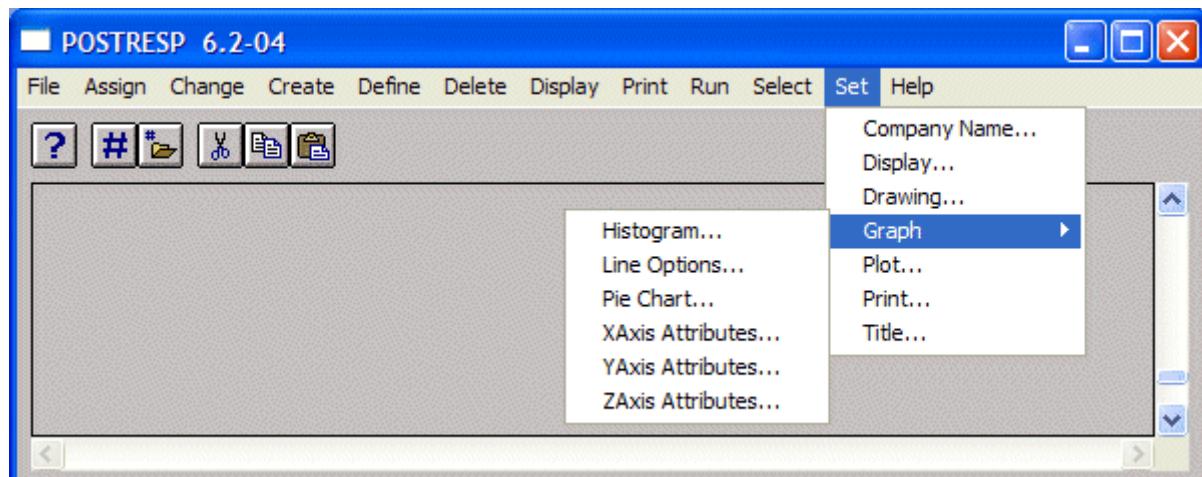
Figure C.57   SET pulldown menu

Company Name

Company Name [   ]

[OK]   [Apply]   [Cancel]

Display Options

Device
```
WINDOWS
DUMMY
```

Destination   [Screen ▼]

☑ Colour

Workstation Window
Left Border	60
Right Border	120
Bottom Border	40
Top Border	100

[OK]   [Apply]   [Cancel]

Drawing Options

☑ Grid
☐ Frame
Character Type   [Software ▼]
Font Type   [Simple ▼]
Font Size   [Relative ▼]
Size factor   [1.0]

[OK]   [Apply]   [Cancel]

Graph Line Options

☑ Marker
Marker Size   [2.0]

Line Type
    Line Number   [1]
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Marker Type
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[OK]   [Apply]   [Cancel]

Pie Chart Options

Exploded Segment
    ○ Segment Name
    ● Off

Filling   [Solid ▼]

Label   Visibility   [Show ▼]
         Orientation   [Horizontal ▼]
         Position   [Automatic ▼]
         Value   [On ▼]

[OK]   [Apply]   [Cancel]

Figure C.58   SET: COMPANY-NAME, DISPLAY, DRAWING, GRAPH LINE-OPTIONS, GRAPH PIE-CHART
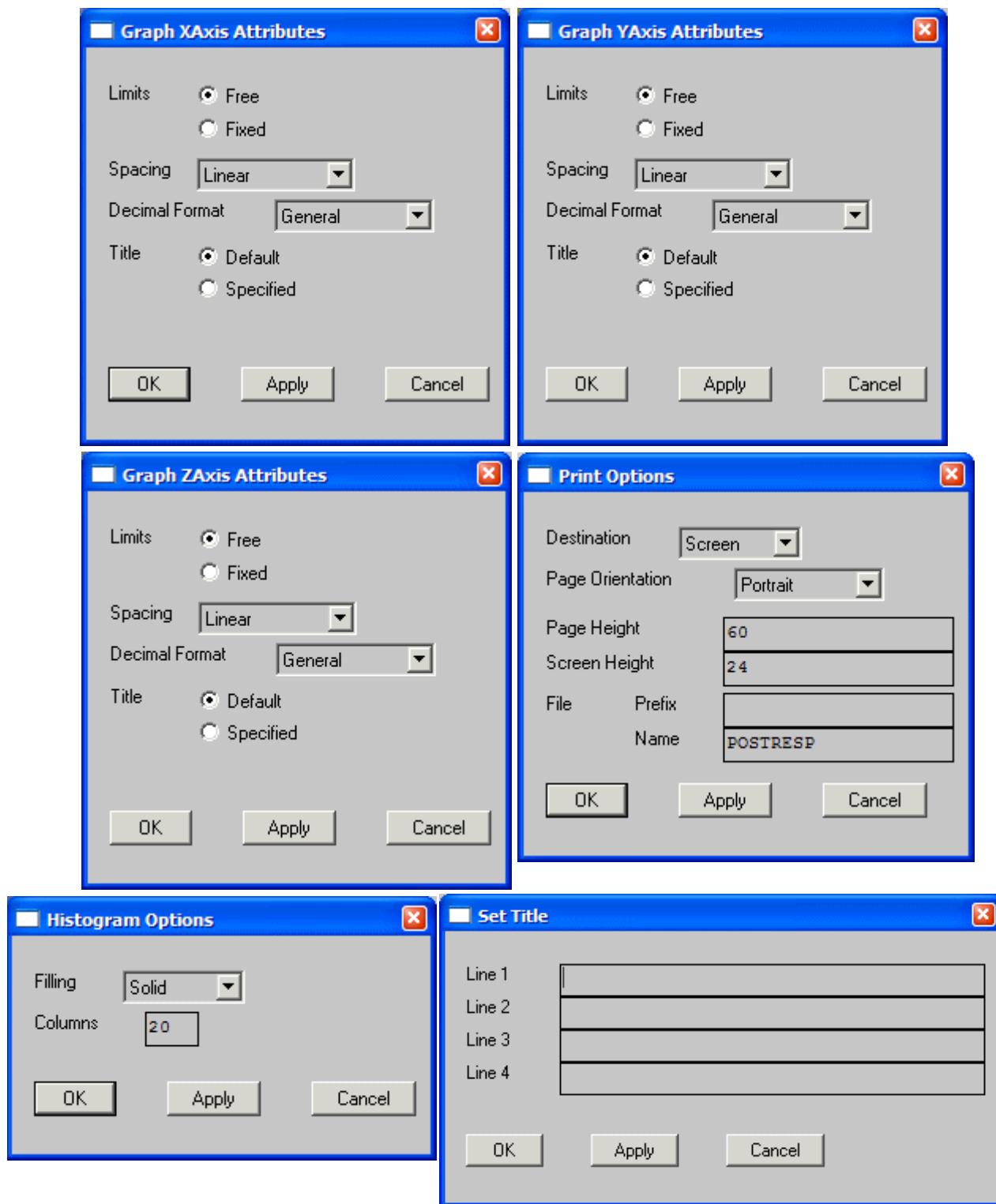
**Figure C.59   SET: GRAPH XAXIS-ATTRIBUTES, GRAPH YAXIS-ATTRIBUTES, GRAPH ZAXIS-ATTRIBUTES, GRAPH HISTOGRAM, TITLE**
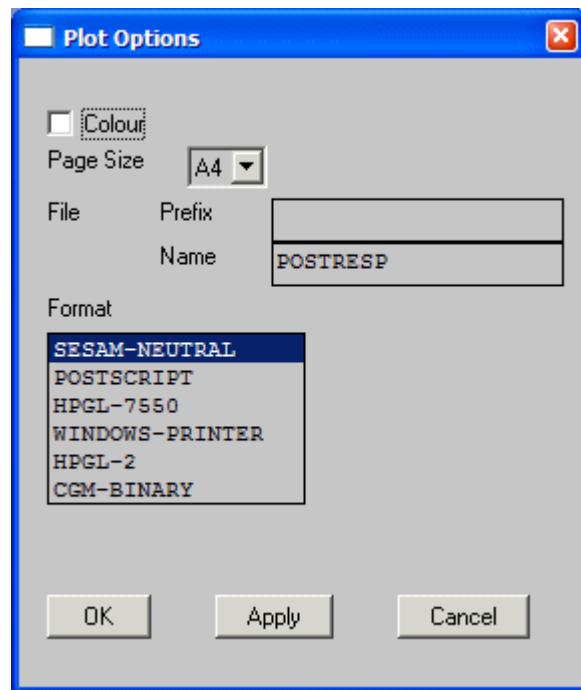
Figure C.60   SET: PLOT

C 13   HELP Menu
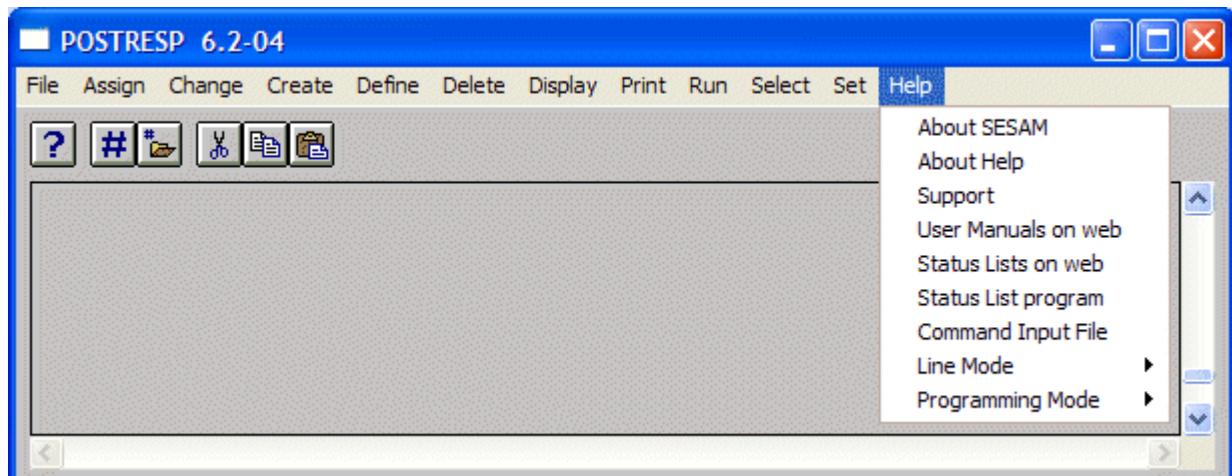
**Figure C.61   HELP pulldown menu**
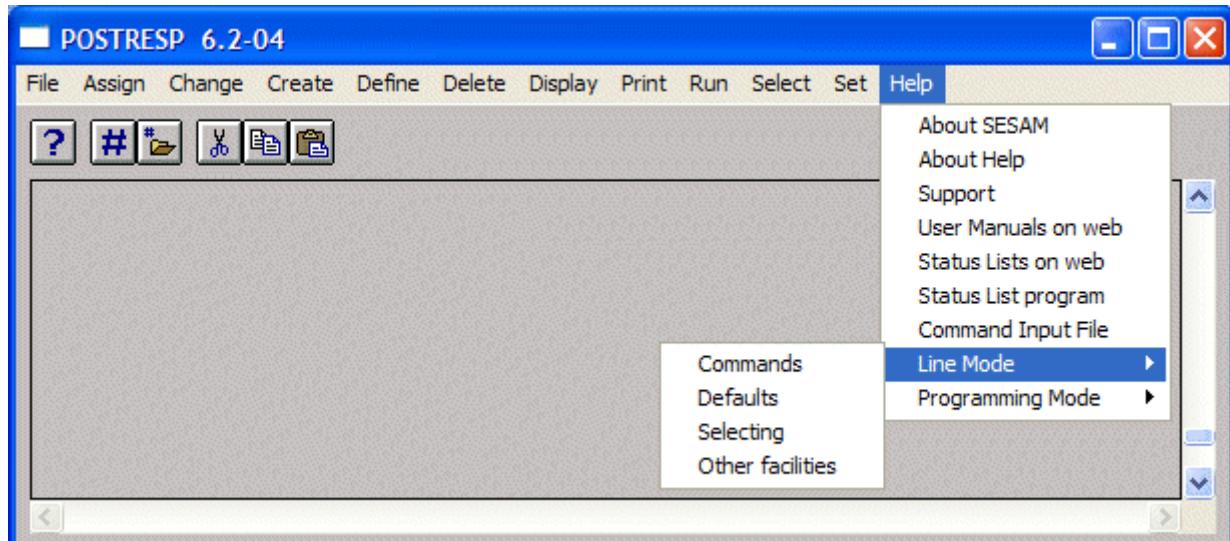
**Figure C.62   HELP LINE-MODE pulldown menu**
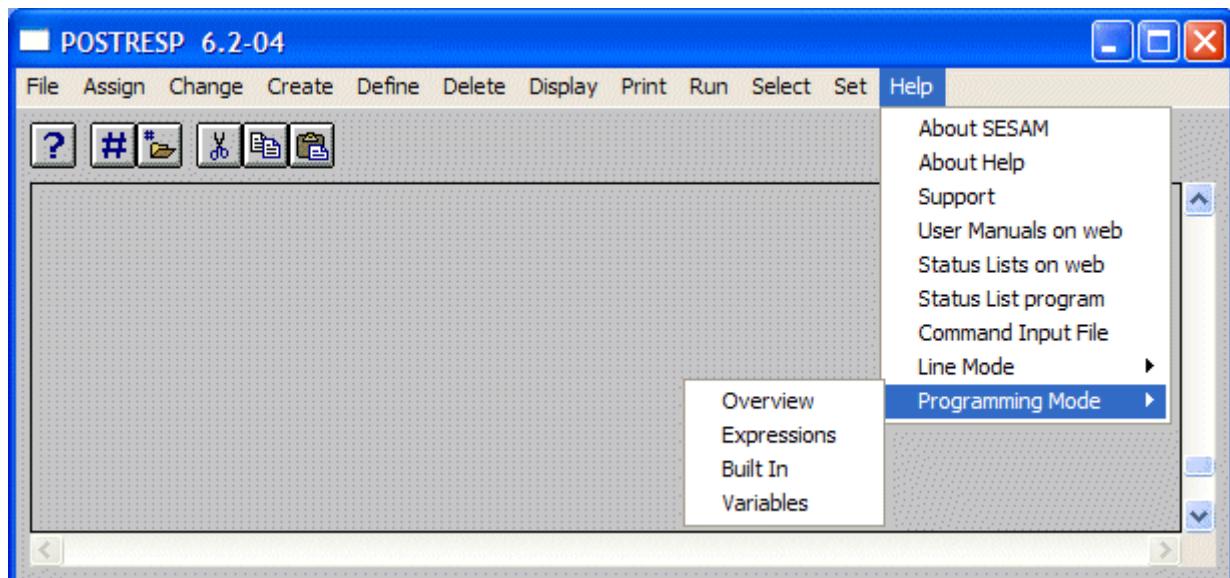
Figure C.63   HELP PROGRAMMING-MODE pulldown menu

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